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Engineer

ENGINEERING 092-80

HE MAGAZINE FOR ARMY ENGINEERS SPRING 1986

BATTLEFIELD INITIATIVES FOR THE '90s

ALSO: USACE SUPPORT OF THE DEH ☐ SOVIET ENGINEERS
BRIGHT STAR '85 ☐ COUNTEROBSTACLE VEHICLE

Obstacles—
Engineers and Maneuver Forces Need Common Terms

Personal Viewpoints

Point

by CPT Michael D. Baehre

Terrain is the first *T* in a commander's METT-T analysis. He considers existing obstacles to determine how reinforcing obstacles can be used to shape the terrain.

AirLand Battle doctrine emphasizes early consideration of obstacles. "Preparation of the ground," states FM 100-5, *Operations*, "cannot be an afterthought."

However, once the commander's analysis is complete, terms don't exist in engineer and maneuver vocabularies to quickly convey how he wants obstacles to contribute to the objective.

If the commander properly considers terrain reinforcement as an integral part of his *concept*, how does he communicate his intentions for use of engineers? How does he focus the obstacle effort?

The need for a common language can be satisfied several ways and deserves serious consideration. For the sake of discussion, I propose two terms with a concept for their use as control measures. The terms are **obstacle zone** and **obstacle belt.**

Until we agree on these or some other official terms and control measures, the maneuver and engineer staffs will continue to discuss obstacle plans in vague, general terms at task force level, or in unrealistic detail at brigade and above.

The Problem

A review of FM 101-5-1, *Operational Terms and Graphics*, and engineer field manuals reveals no clearly documented engineer control measures short of designating specific obstacles. The result is that engineer effort is focused by the allocation of obstacle resources (engineer units and materials) to unit areas. While this constrains the engineer effort in each unit area (assuming the subordinate commander fully uses the assets), it doesn't focus the manner in which obstacles are used nor their general location.

Current engineer doctrine and common sense both dictate that individual obstacles be planned and sited at the lowest level possible to ensure they are tied into other obstacles and covered by direct and indirect fire. The normal capabilities of a division or brigade engineer staff don't allow them to conduct the reconnaissance, detailed planning or coordination required to properly site a large number of individual obstacles.

Obstacle planning from the bottom up becomes a necessity. Therefore, teams and task forces develop obstacle plans (collections of obstacles), which are then reconciled with higher maneuver plans at brigade, and finally passed to division for further integration. Until the plans filter up, the commanders at each level don't know whether subordinate units are using obstacle assets as intended or whether the obstacle plans restrict maneuver's flexibility. Instead of focusing the engineer effort, this resource allocation method merely assigns capability.

(continued on page 23)

Counterpoint

by MAJ Arthur Marubbio

The concept of obstacle zones and belts is by no means new. It pops up continually in briefings given to maneuver commanders. The concept described by CPT Baehre offers a good proposal for a standard definition of terms, but causes some immediate problems.

First and foremost is the restrictive nature of division and brigade designated obstacle areas. Predesignated zones and belts remove considerable flexibility from the battalion/task force commander. They restrict his ability to shape the battlefield based on his direct observation of the terrain—a perspective not always shared by the division level planners.

A second problem arises when constructing the unconstrained engineer estimate at the brigade and division levels. This estimate is based on the physical plotting of anticipated individual obstacles and is the primary means of allocating resources to subordinate units. How can the division and brigade planners request and allocate resources based on the general definition of zones and belts?

Finally, the physical location and status of individual obstacles are of interest to maneuver commanders at all levels. Every staff engineer must be capable of providing the status of any obstacle within their maneuver commander's area of responsibility.

Do zones and belts imply that a detailed estimate was conducted and an obstacle listing with current status is, therefore, available at division? At brigade? This does not appear to be the case!

I believe the current planning process must remain intact. The engineer estimate must be completed and the resources allocated based on that estimate. The maneuver commander at the battalion/task force level must retain the capability of shaping the battlefield.

Once this procedure is complete we might consider the use of zones and belts to ease the *graphic clutter* of the engineer obstacle overlay. But the engineer must be prepared to discuss obstacle status in detail.

MAJ Arthur Marubbio is chief of the Engineer Branch, Department of Combined Arms, USAES.

Engineer

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AT URBANA-CHAMPAIGN

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On the Cover

Art by Nicholas Mosura captures the *warrior spirit* of Engineer Battlefield Initiatives of the '90s.

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ENGINEER (ISSN 0046-1989) is published quarterly by the U.S. Army Engineer Center and Fort Belvoir, VA. Unless specifically stated, material does not necessarily reflect official policy, thinking nor endorsement by any agency of the U.S. Army. ENGINEER's objectives are to provide a forum for the exchange of ideas, to inform, and to promote the professional development of all members of the Army engineer community.

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News & Notes

WES Keeps the Army Moving

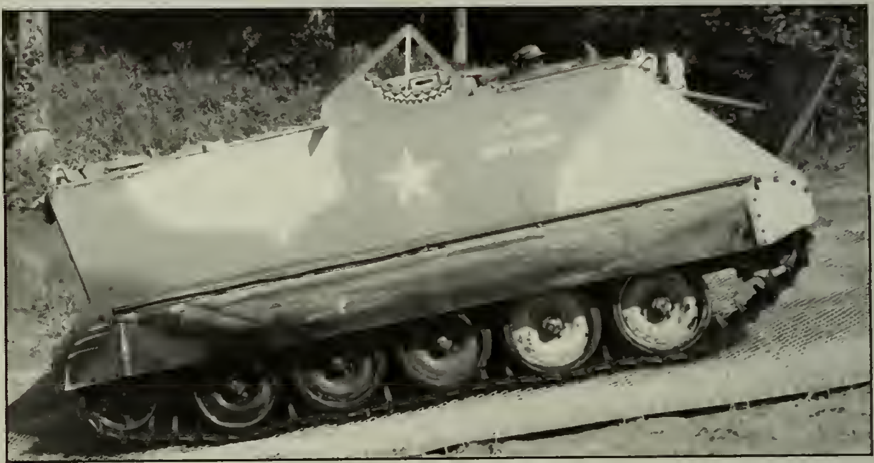
A winning Army must be highly mobile. However, crossing streams, beaches and minefields are common wartime tasks that still present problems. At the U.S. Army Engineer Waterways Experiment Station (WES) in Vicksburg, MS, engineers perform research in all of these areas.

Flexmat

River crossing operations are an integral part of land warfare. For this reason, WES engineers are studying different access/egress methods. One solution is to overlay surfacing material on marginal soils and steep riverbanks.

A promising overlay material, called flexmat, consists of woven steel fabric, neoprene-coated nylon membrane surfacing, and extruded aluminum support channels. This system comes in 50-foot sections that are 16.4 feet wide. The system rolls into a package 3 feet in diameter.

An assault vehicle such as the M113 armored personnel carrier can transport the sections. The M113 can deploy the flexmat up a slope, or the flexmat can be hand deployed down the slope. Current research includes the evaluation of a mechanism to convey and launch the flexmat system.



Using the new flexmat, an M113 APC emerges from a lake test site. Flexmat is designed for marginal soils and steep riverbanks.

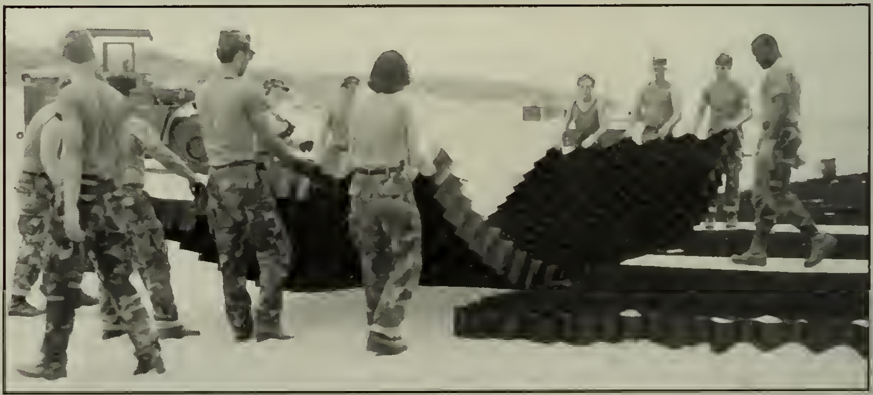
Sand Grid Confinement Cells

Crossing beaches with personnel and supplies creates another set of problems. The most successful solutions to these problems are sand grid confinement roads.

Grids made of high density polyethylene are manufactured and shipped in 4-inch thick sections that are easily expanded to 20 feet during road construction. Two trucks can carry enough grid for one mile of road.

Personnel expand the grid and fill the cells with sand. A light layer of liquid asphalt can be applied to provide a more durable wearing surface for wheeled traffic.

Sand grids are also finding use in field fortifications. One study used the grids successfully as barriers and revetments to protect artillery emplacements.



Sand grids are expanded and filled with sand. The 4-inch thick sections can be expanded to 20 feet and a light layer of liquid asphalt can be applied to provide a durable surface for wheeled traffic.

Construction of a sand grid barrier for a 155mm self-propelled howitzer emplacement, using only hand labor, required 132 manhours. This is almost half the time needed to build a similar sandbag position. Using a front-end loader to place the soil would have reduced the construction time even more.

A sand grid barrier is easy to disassemble and is reusable. Future uses for grids as barriers include load-bearing walls and vehicle obstacles to counter terrorist threats.

Minefield Detection

WES is also evaluating optically aligned images that provide data simultaneously in multiple wave-length bands. An active laser source investigation is also ongoing in the area of minefield detection. One or more systems may produce images to help tomorrow's Army locate and neutralize minefields faster and more efficiently.

WES is also researching new remote methods for minefield detection in different terrains and environments. Engineers are testing several types of scanners individually and in combination. The thermal line scanner provides high resolution thermal images for daytime and nighttime photography.

Digital data processing techniques reduce terrain background clutter. Single channel image data separates mines from background terrain. Under some conditions, this system results in numerous *false* mine targets within the image.

Engineers Compete in NBC Olympics

PFC Greg Bowling hurls a dummy grenade at his target during the 18th Engineer Brigade's NBC Olympics. **Photo by Tony Adams**

Nearly 350 soldiers from the 18th Engineer Brigade squared off in NBC Olympics competition to find out who was best in MOPP gear.

CPT William Eck, the brigade chemical officer, said, "We wanted to demonstrate that NBC and military skills could be accomplished while wearing protective equipment. At the same time, we wanted to have a good time."

The brigade's five battalions and company headquarters competed in the NBC Olympics. Except for protective mask assembly, all events were performed in MOPP gear:

- Playing volleyball
- Testing driving skills
- Erecting an RC-292 antenna
- Orienteering
- Exchanging MOPP gear
- Assembling protective masks
- Firing an M16 for score
- Assembling an M16
- Setting up a GP small tent
- Using German firefighting equipment
- Throwing a grenade
- Running a relay race

Eck said the relay race was the hardest event physically. However, exchanging MOPP gear was also difficult because it's part of the new NBC training doctrine and unfamiliar to many.

The brigade NBC office plans to make the NBC Olympics an annual event.

Soviet Acquisition of Military Technology

The Soviet Union has a massive, well-organized campaign to acquire Western technology for its weapons and military equipment projects. Each year Moscow receives thousands of pieces of Western equipment and thousands of unclassified, classified, and proprietary documents as part of this campaign.

Understanding the Soviet effort is a critical first step in protecting Western technology and preventing it from being turned against the West. *Soviet Acquisition of Military Significant Western Technology: An Update* reveals in detail the structure of these Soviet programs and gives examples of Soviet requirements and successes.

Copies of this 40-page publication can be obtained by sending a check or money order for $2 payable to the Superintendent of Documents, U.S. Government Printing Office, Dept. SSMC, Washington, D.C. 20402.

Engineers Create Tire House for MOUT Training

SP4 Robert Ogden, 92nd Engineer Battalion, looks through piles of tires provided at no cost by a local tire company and the property disposal offices at Fort Stewart, Fort Gordon, and Charleston Air Force Base.

The 92nd Engineer Battalion, Fort Stewart, GA, worked hard to turn 10,000 used tires into a house that absorbs live ammunition while soldiers practice military operations in urban terrain (MOUT). The 1st Battalion (Ranger), 75th Infantry Division, initiated the construction.

MOUT training consists mainly of room-clearing techniques. Units using the building can practice external and internal tactics. Internal tactics will consist of moving from room to room safely or clearing a closet of the enemy. External tactics will have a unit attack and enter the building from the nearby treeline. Silhouettes will be placed in the windows for targets.

Platoons from Company B, 92nd Engineer Battalion, began construction by sinking 8 x 8-inch timbers 4 feet into the ground and pouring concrete around them to stabilize them. Then, using the timbers much like pegs in a ring toss game, they dropped tires over the timbers, individually filled the tires with dirt and wired them together.

The end result was a 44 x 90-foot structure with 9-foot walls, no ceiling and a dirt floor. The tire house has six separate rooms, each with a closet. The total cost of the project is expected to be $129,082, according to 2LT Kevin Cronin, assistant construction officer.

The 35 soldiers who spent six hours a day working on the project gave several reasons for their motivation in this project.

"We support the Rangers. If they need us, we're there for them," said PFC Joseph Walsh, a carpentry and masonry specialist.

SFC Jerry Mathis, NCOIC, said the project gave them training in laying out the site and mixing and placing concrete.

Units will be able to use a variety of weapons and live fire ammunition in the house. The M16 rifle, .45 caliber pistol, 9mm submachine gun, hand grenades, shotguns, and the 7.62 sniper rifle can all be used. In addition to live ammunition, units will use blanks and do Multiple Integrated Laser Engagement System (MILES) training in the building.

Army Generates Computer Images To Plan Future Battles

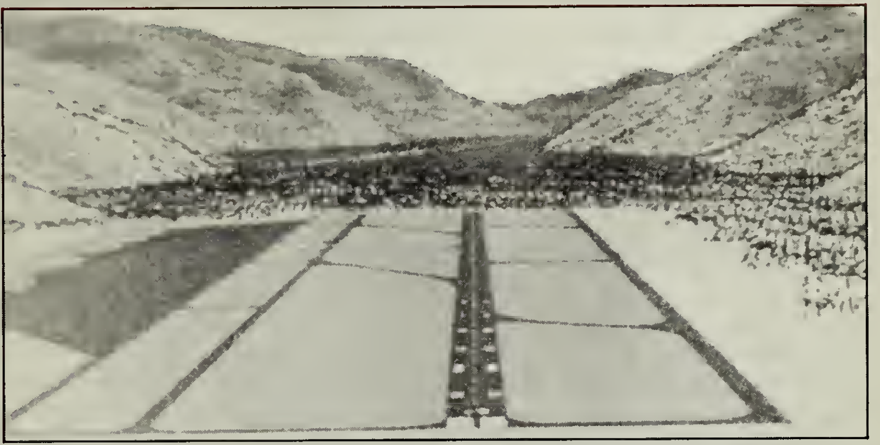
Military pilots often learn their trade by *flying* aircraft simulators through computer-generated terrain scenes. Similar scenes may someday help the Army plan battles and test missiles.

Two Army organizations—the Engineer Topographic Laboratories (ETL) and the Missile Command—have teamed with the Defense Advanced Research Projects Agency to apply computer image generation (CIG) to these tasks. Over the next three years, Boeing Aerospace Company will develop four specialized CIG systems for the Army, two for battlefield management and two for missile simulation.

The CIG system combines digital terrain elevation and feature data with information from maps, photographs, and satellite imagery. It produces shaded three-dimensional perspectives of the terrain. These scenes show natural terrain features as well as objects like bridges, buildings and roads. Clouds, fog or snow can be added for extra realism.

Computer-generated terrain scenes could help commanders study their areas of operation and plan their courses of action. Commanders could examine the terrain from any viewpoint and location and try out different battle tactics. They could position troops, deploy smoke, blow up dams, or simulate other maneuvers and predict how these actions would affect the battlefield and the battle.

Boeing will deliver an initial software-based system to ETL in the fall of 1986. The second system, scheduled for the following fall, will transfer the image generation function from software to hardware. This shift will speed processing time from 5 minutes per frame to 30 frames per second. ETL scientists will test these systems to develop techniques that can help commanders analyze the terrain and make tactical decisions.



Computer-generated scenes—realistic pictures of the terrain similar to those used in flight simulators—may help commanders plan battlefield maneuvers someday.

Letter to the Editor

I enjoyed Captain William J. Sandbrook's article, *The Engineer Officer: Advisor or Leader, A study of the Battle of Petersburg,* which drew forth examples of good and bad use of engineer officers on the battlefield. I offer two more thoughts in extension of the author's points.

First, I agree with his conclusion that "the Army still needs engineer leaders for the front lines and engineer advisors for the headquarters." However, at some points in the chain of command these should be the same. The clout that the division engineer/battalion commander can bring to his duties as he wears both the *commander* hat and *division engineer* hat ensures that the direction of engineer forces in support of a division does not get separated from the advice given to the major general. True, the assistant division engineer (ADE) must provide a full time presence at the division CP and should be one of the more experienced engineer officers in the division. But the battalion commander is also *the* senior engineer.

Second, the engineer staff advisor (whether the platoon leader providing advice to the maneuver commander, or the brigade engineer, or the ADE) must stay close to the S-3 or G-3. As the engineers support in the areas of mobility, countermobility, survivability and other "sapper" duties, the advice must be coordinated with the principal staff advisor concerned—the S-3 or G-3. Further, engineers should be surrendered willingly to brigade and division S-3/G-3 slots, and replaced with equally competent and experienced officers. Of all the company grade officers, perhaps excluding only the armored cavalry lieutenant or captain, the engineer officer often gets the best opportunities to learn combined arms. He has been exposed to infantry, armor, and artillery real time warfighting issues, as well as providing engineer support across the battlefield. He sees the big picture early. We have in the Corps of Engineers a pretty good track record of officers who have become brigade S-3s, division G-3s and chiefs of staff, and occasionally assistant division commanders. I hope the Corps of Engineers senior officers continue to seek opportunities to provide tested engineers in those positions. The engineers of course profit, and so does the Army on the battlefield.

—LTG E. R. HEIBERG III
Chief of Engineers

HP-41 Modules Available

A limited number of demonstration modules for the Hewlett Packard HP-41 calculator are available on a "first come, first served" basis from CERL. The read-only-memory (ROM) module for the handheld programmable calculator includes programs on:

- Demolition formulas
- Minefield logistics
- Wire obstacle logistics
- Bridge classifications
- Road crater formulas
- Network analysis
- Programming utility routines

If you want copies of the modules, you can request them in writing from USA-CERL, ATTN: CERL-FS (Mr. Deponai), P.O. Box 4005, Champaign, IL 61820.

Or you may call Mr John Deponai at (217) 373-7271, FTS 958-7271, AUTOVON through Chanute AFB, or toll free 800-USA-CERL (outside Illinois), 800-252-7122 (within Illinois).

Engineer

CLEAR THE WAY

by MG Richard S. Kem, Commandant, U.S. Army Engineer School

We Stand at the Watershed

Since I became commandant nearly two years ago, I've visited with many of you to assess how combat engineers fit into this Army. We've got a lot that needs fixing. With your help, the Engineer School has designed a master plan for improvements that I call ***Combat Engineer Battlefield Initiatives for the '90s***—a thrust to modernize engineers as part of the Army of Excellence and provide a linkage to Army 21, *the Army of the future.* I want to share highlights of this plan with you.

We stand at a watershed! At a time when the Army has fielded a new generation of combat vehicles and AirLand Battle doctrine places a premium on mobility, the engineers are viewed as a combat multiplier that adds strength, depth and flexibility. But we are often viewed as cumbersome and deliberate—equipped heavy, unprotected and slow. Engineers are handicapped by an antiquated force structure that limits our productivity and our ability to respond to maneuver commanders' needs.

Now, after two decades of research and development, we are on the verge of modernization. The technology for a new generation of combat engineer systems has been developed. Improved capability will allow us to create a more efficient organizational structure. A new breed of engineer —*the sapper*—is emerging (*story page 19*). Dynamic, comprehensive change is at hand.

Equipment

Engineers are essential on today's battlefield, but our soldiers don't have the tools they need for the jobs they are being asked to do. We cannot continue to bring new engineer equipment and materiel into the Army at a stutter step.

Despite the fact that defense budgets are decreasing, engineers need a sustained equipment modernization program. Recent Israeli experience underscores the importance of well-equipped engineers to the successful combined arms team. Consider the comments I heard from the Israeli defense force during a visit last fall:

From the Armored Division Commander who said, "In Lebanon, the real heros were our engineers . . . Without them I couldn't advance a mile. Their speed was my speed."

From the Armored Division Commander who said, "In Lebanon, the real heroes were our engineers...Without them I couldn't advance a mile. Their speed was my speed."

They were saying that success rides on responsive engineer support, but the speed of the bulldozer is too slow. If the Army is going to execute AirLand Battle doctrine . . . if the Army is going to fight the deep battle, then engineers must be truly available at the FLOT—ready to obtain freedom of maneuver—***agility***—for the ground force.

The mechanization of the forward deployed engineer corps battalions in Europe has begun. The M9 ACE is coming (*story page 26*)—fielded now to the 13th Engineer Battalion, 7th Infantry Division (Light). FASCAM capability is being introduced into the engineer force—the 9th Infantry Division and Europe are receiving their GEMMS. MICLIC will change our ability to breach complex obstacles. The technology for a host of new systems like the COV (*story page 28*), the TEXS, Volcano, and the HAB is on the horizon (*story page 20*) as our Engineer Materiel Master Plan charts our transition to the future.

Organization

Our objective is to be available at the FLOT and in the deep attack—to be capable, protected, mobile and productive—and most important, to be responsive to the maneuver commander. But new equipment alone is not the panacea. We must forge a new engineer architecture. We need:

- More compact units with a higher ratio of equipment to manpower.
- Greater integration with the Army field structure at all levels.
- A forward shift in command and control.
- Reduced overhead and greater productivity.

Battlefield Initiatives for the '90s

Today in the field you are trying valiantly to make our World War II-vintage organizational architecture work through ad hoc command and control arrangements and task forces. The missions haven't changed with AirLand Battle doctrine; the implications have.

The emphasis is on rapid tempo, greater distances, quick shifts from mode to mode, and shorter warning times. The length and depth of the battlefield extend over a greater operational area.

But the most significant challenge is time. The windows in which the combined arms team must act are very short. We no longer have the response time necessary to shift engineer units across the battlefield — to pull off bridge and mine missions in one place, reattach, move to another sector, and be ready to support an attack and breach a complex obstacle.

Yet under our current structure, the center of mass of engineer assets is back at corps. Nearly 70% of engineer combat assets are assigned to corps despite the fact that more than 60% are required in the division and brigade areas. Units are task-organized forward creating complicated command and control arrangements at platoon, company, brigade, battalion, and division.

Habitual association—the key to integrating engineers into the commander's scheme of maneuver—suffers at every echelon. The engineer platoon leader is overloaded to the point that he has difficulty juggling his many responsibilities for mission execution and staff. Logistics and maintenance — already complex — become complicated to the point of not working as the battle progresses.

We are determined to solve our architectural problems—to fix the systemic base so we no longer must accept Band Aid solutions. We made important progress last year with the redesign of the engineer combat battalion (heavy) to give robustness to engineer construction and defense capability in the rear area (*story page 16*).

The Engineer School is currently developing a plan to restructure the engineer assets. It brings together the requirements of AirLand Battle, the lessons learned from field exercises like Reforger and the NTC, and the results of our worldwide engineer analyses. This aggregate plan is called E-FORCE (*story page 10*).

Missions and Challenges

AirLand Battle poses new challenges for all engineers. Change is the companion of modernization. As we rethink our organization to make better use of engineer assets, we must keep in mind the realities of AirLand Battle.

Don't fall into the trap of limiting your definition of AirLand Battle to the close or the deep operation. The engineers' contribution to the combined arms team is not exclusively in the brigade area. True, it is the focal point of ground combat—bayonet to bayonet. But this is not the way the Army describes AirLand Battle. In order to have the deep operation, all elements must be synchronized successfully throughout the depth of the battlefield.

Missions and challenges abound for all of us in AirLand Battle. Let's not overlook the fact that the combat heavy unit in the rear may be fully engaged in hostile operations at an airfield that we are desperately trying to keep open to sustain the flow of troops to continue the fight.

Remember the terrain analysis team that plays an increasingly vital role in the commander's success as new topographic systems provide information critical to his shaping of terrain and scheme of manuever.

We have a number of things we need to fix. But leadership throughout our force and the way we go at doing our jobs are not among them. These are the strengths we share.

When I think of *warrior spirit* the word that comes to mind is audacity: to execute violently, to confront the issues . . . to go at it.

I ask you to keep charging. Keep convincing that maneuver commander that engineers are valued partners in the combined arms team. But make sure he knows that your organization is antiquated and your tools are obsolete—make sure he understands when you have to put a Band Aid on a command and control arrangement to make it work. Ensure he knows what you could achieve if properly equipped and organized for battle.

Go get credit for your *drive on, can do, essayons* leadership and your warrior spirit. But make sure he knows if you were effectively organized and equipped with the proper tools you could devote your warrior spirit to being even more responsive to his needs.

BRIDGE THE GAP

by CSM Charles T. Tucker, U.S. Army Engineer Center & School

Adjusting to Change:
The Leadership Challenge

As the Army modernizes combat engineers to better support the combined arms team in the AirLand Battle, engineer noncommissioned officers face the challenge of helping troops adjust to new organizations and equipment.

During my visits, many of you have said you are pleased with the new equipment and the quality of initial training provided by new equipment training teams. However, some of you may receive no training prior to joining units undergoing changes in equipment and organization. You must prepare to deal with predictable problems like:

- Conscious or unconscious resistance to change because of uncertainty and unfamiliarity.
- The tendency for units undergoing rapid change to become unmanageable and unproductive because of the complexity of the effort.
- Hampered teamwork due to personnel changes as soldiers move to new teams and new working relationships.

While change creates opportunities to improve professionally, it also threatens the tried and true. People resist change almost instinctively because the old ways are well known and the new ways aren't yet established. Soldiers who are experts with old equipment may resist change because they feel they are not adept with the new equipment and may lose status.

NCOs and their officer counterparts must work together to overcome this natural resistance by explaining the advantages of the new equipment or organization. Information and experience are the best cures for uncertainty. As soon as you receive information or training, start familiarizing your troops. Read everything you see about the proposed force structure and equipment developments. Granted at this point information may be limited. But with a little research you can find helpful material.

This issue of *ENGINEER* makes a good beginning. You should also receive the Engineer Center Team Minutes which are published monthly by the USACE, Directorate of Combat Developments (DCD), ATTN: ATZA-CDP, Stop 281, Fort Belvoir, VA 22060-5281. Information notes and bulletins published by MACOM engineers and laboratories also contain useful information. Specific questions can be directed to the Program Management Office of DCD or the Engineer Hotline.

Don't overlook the fact that the new frequently builds upon technological advances and improvements to the old. Keys to understanding the deployment of new equipment are often found in field manuals that explain similar, existing systems. You would be wise to get together with your commander, platoon leader and subordinate NCOs to review field manuals on the utilization of like equipment.

During the transition, you must respond to the demands of both the old and new systems. The potential for conflicting priorities, unclear guidance and ambiguous situations increases. I think you will agree this is truly a leadership challenge. The attitude *"I know you've got problems, but so do I, so go out there and work it out"* isn't conducive to a smooth transition.

You must create a climate of understanding that allows soldiers to express their frustrations and apprehensions. This does not mean you should tolerate lack of discipline. But soldiers need opportunities to air their concerns.

Change, by its very nature, is disruptive. The disbandment of intact teams, the creation of new teams, and all the associated changes in procedures and reporting relationships can cause units which once functioned smoothly to lose effectiveness.

To offset this, stress the things that will stay the same. Reassure soldiers that while some things are changing, others are not. You must present a clear, time-phased plan so troops can see they will soon be through the transition and things will return to normal.

Units where officers and NCOs welcome change and the opportunity it brings will have the greatest success. Keep your soldiers informed. Let them express their frustrations, problems and apprehensions. Increase their confidence by devoting ample time to training. Give awards and incentives that recognize superior performance and reestablish the value of teamwork.

Most importantly, remember the unit is looking to you for leadership.

Career Notes

Commissioned Officers Branch

Advanced Civil School Board:

August 31, 1986 is the deadline for applications to the Advanced Civil School Board which will meet September 1, 1986. The procedure for applying to the Board is outlined in AR 621-1, *Training of Military Personnel at Civilian Institutions.* All officers who have previously sent in applications will automatically be considered unless they have withdrawn their applications.

The following fully funded quotas were available in FY 86.

USMA	27
Civil Engineering	16
Engineering Administration	4
General Engineering	5
Electrical Engineering	1
Topography/Photography	2
Geodetic Science	1
ORSA	2
Area Studies	2
Journalism	1
Robotics	1

FY 87 quotas will be similar. Additional quotas for Degree Completion, Co-op, Permissive TDY, and Training with Industry will also be available.

Officers selected to attend ACS who will *not* complete 24 months of a CONUS tour or the prescribed overseas tour by the start of school will be deferred until the next school year.

A predetermined number of officers will be identified as alternates. This alternate list will be used for two years to fill unprogrammed vacancies.

All officers applying to ACS should be branch qualified (TOE experience, advanced course completion, and successful company command). Each application should include a current photo, transcripts and GRE test scores. Selection is based on the *whole person* concept with particular emphasis on successful company command.

The results of the Advanced Civil School Board will be released in October. For additional information, contact CPT Pete Cooksey, (202) 325-7426, AV 221.

CGSC Board:

The Command and General Staff College Board will meet October 7 to November 21, 1986. Officers selected for promotion to major in 1985 plus majors in year groups '73, '74, and '75 will be considered.

LTC Promotion Board:

The FY 86 lieutenant colonel active duty promotion board will convene from July 15 to August 29, 1986. Year group '71 will be in the primary zone; year group '72 will be below the zone. To be considered for promotion, you must have completed CGSC before June 15, 1986.

Career Tips:

Make sure your ORB, phone number, address, photo, and fiche are up-to-date.

E-FORCE

by MG Richard S. Kem, MAJ J. Richard Capka and MAJ Houng Y. Soo

AirLand Battle doctrine stresses combined arms operations over large areas. Its four tenets—agility, flexibility, depth and synchronization—accentuate the role of the combat engineer on the modern battlefield.

It demands increased tempo and greater distances from all functional engineer missions—*mobility, countermobility, survivability, general engineering* and *topography*. In other words, engineers must accomplish the same tasks over a larger area in significantly less time.

This comes at a time when combat engineers are at a watershed. The Army has embraced a new *warfight* doctrine that stresses maneuverability and is equipping with more mobile and lethal fighting systems. Yet, the combat engineer—the man who converts mobility to maneuverability—finds himself supporting a rapidly modernizing battlefield with a cumbersome World War II organizational architecture and antiquated equipment. In short, today's combat engineers are the weakest link in the battlefield combined arms team.

The Engineer School is currently developing E-FORCE—a plan to restructure engineer assets throughout the depth of the battlefield. E-FORCE brings together the requirements of AirLand Battle, the lessons learned from exercises like Reforger and the National Training Center (NTC), the results of analyses of worldwide engineer requirements, and studies of new equipment productivity.

The goal is to fix systemic defects in engineer organizations . . . defects that until now prevented the combat engineer from providing timely, responsive support to the maneuver commander executing AirLand Battle doctrine.

E-FORCE addresses the entire spectrum of engineer organizations from the combat zone to the RCZ/COMMZ. E-FORCE consists of three components:

- Support to close combat *heavy* forces in the forward combat zone.
- Support to close combat *light* forces in the forward combat zone.
- Support for the rear combat zone/communications zone.

Two of these—support to the close combat light and for the rear combat zone—have already been approved for implementation. Engineer support to close combat light forces was reorganized to meet special requirements of air transportability to and within the theater of operations. As a result, the engineer support package to XVIII ABN Corps contains light corps engineer battalions and light equipment companies that are readily transportable to augment the light division engineers in the contingency theater.

In the RCZ/COMMZ:

- The topographic engineer battalion has been reorganized and tailored to meet theater-specific needs.
- The engineer combat battalion (heavy) has been redesigned to increase horizontal capability relative to vertical capability, reflecting battlefield requirements.
- Specialized teams and detachments were formed at echelons above corps to centralize control and decentralize execution of specialized functions such as well drilling, diving and asphalt operations.

Now our energies are focused on improving support to the close combat heavy forces—on giving the maneuver commander the responsiveness he needs to win on the modern battlefield.

The Problem

Engineer support to the close combat heavy combined arms team is broken. Insufficient engineers are organic to maneuver forces. Attempts to overcome the deficiency by assigning ad hoc task forces forward out of corps assets overload engineers at all echelons. Command and control (C^2), communications, maintenance, and logistics become complicated to the point of not working as the battle progresses. The current structure also fosters a false sense of flexibility at the corps level.

Studies and our long term experience in Europe show that each maneuver brigade in the forward combat zone requires at least one engineer battalion. Typically, the need is met by augmenting the divisional engineer battalion with corps combat battalions. Even with the mechanization of corps combat battalions, there are significant differences between divisional and corps battalions.

For example, divisional engineers have AVLBs and CEVs; corps units do not. So, we patch together ad hoc task organizations in a vain effort to ensure sufficient engineers and equipment are available to support maneuver forces. Figure 1 shows how this task organization is deployed on the battlefield.

This complex arrangement strains towards a solution. The divisional engineer leader at each maneuver echelon is dual-hatted—serving as both commander of his unit and the maneuver commander's engineer advisor.

For example, the engineer battalion commander not only exercises command and control over his battalion which is spread throughout the division area; he is also responsible to the division commander for orchestrating the activities of all corps' engineer assets that support his maneuver echelon. His attentions are divided and his staff is overtaxed.

ENGINEER BATTLEFIELD LAYOUT
DEFENSE SCENARIO
CURRENT

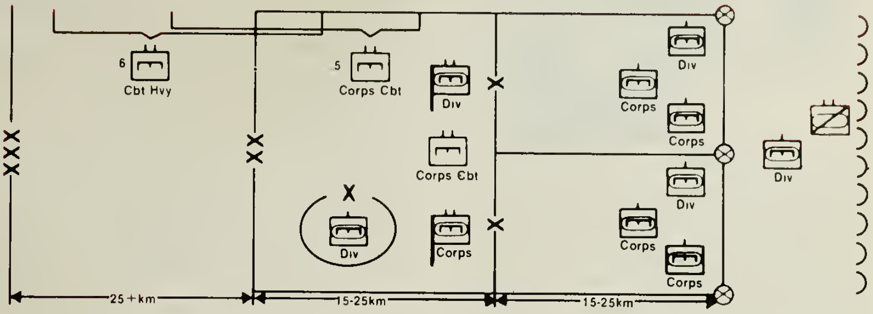


Figure 1

The divisional platoon leader who supports a battalion task force is the most overloaded engineer unit commander. He serves simultaneously as an engineer planner, executor, coordinator/integrator, and principal advisor to the lieutenant colonel maneuver commander. Yet he is one of the youngest officers in the division—typically 20 to 24 years old and probably fresh out of EOBC.

Consider the task force engineer's area of responsibility compared with that of his infantry counterpart (Figure 2). Experience at NTC has borne out how easily the task force engineer (platoon leader) is overcome by events. Maneuver commanders at NTC quickly recognize that their engineer platoon leaders—no matter how motivated—cannot succeed as *both* planners and executors. This limits the engineer support available to a task force!

There is also another C^2 problem. At each maneuver echelon, the level of engineer command and control is inappropriate in relation to the rest of the combined arms team. For example, at brigade level, the brigade commander works with armor, infantry, artillery, and support battalion commanders and battalion staffs (Figure 3). The disconnect is with the engineer. His engineer commander is a company commander who must overcome the difference in level of experience between himself and battalion commanders to get into the inner circle.

Ad hoc engineer task force organizations also play havoc with communications. Units compelled to operate at extended ranges require AM as well as FM communications. Multiple nets must be used to establish command and control with engineer task forces, supported units and parent units. The differences in assigned frequencies, CEOIs and

ENGINEER PLATOON LEADER'S RESPONSIBILITIES

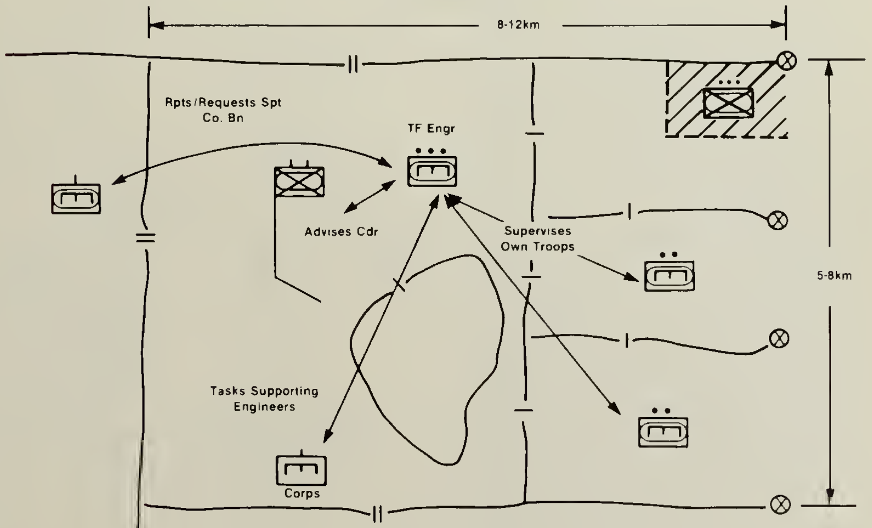


Figure 2

COMSEC keying equipment exacerbate the problems. Engineer responsiveness is hindered.

Similiar problems arise in the maintenance and supply arenas. Divisional units are supported by DISCOM; however, corps units operating in the division area are still tied to their COSCOM umbilical cord. The issue is further complicated because maintenance and supply relationships change as command support relationships shift. The result? Corps units operating forward put unresourced burdens on an already overloaded DISCOM and must work with an external logistical tail.

CURRENT C²

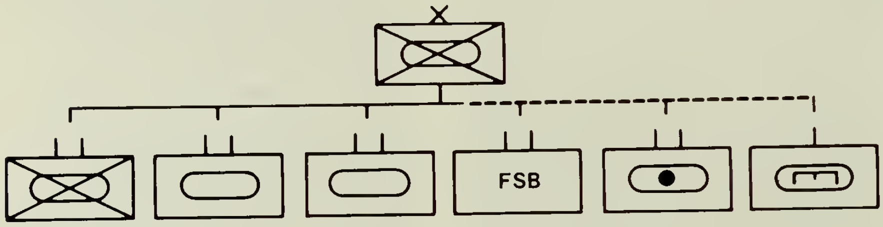


Figure 3

Habitual association—a close, continuous relationship between all elements—is vital to successful integration of the combined arms team. It enables the maneuver commander to mold the team he will go to war with—to put them through grueling drills that instill confidence and cohesion. Yet, stationing and our current architecture deny corps units opportunities to train in habitual association with their *go to war* divisions. They become pick-up units rather than well drilled combined arms partners capable of anticipating the commander's intent and acting with mission type orders.

Perhaps the most serious pitfall inherent in our current structure is a false impression of flexibility at the corps level. The original intent of the current structure was to provide the corps commander with the assets and the flexibility to provide engineer support over a broad area and still weigh the main effort. When subjected to the rapid tempo of AirLand Battle, this apparent flexibility dwindles to illusion.

For example, consider the scenario in Figure 4. The corps commander is required to control the FLOT, contain the penetration from the center, and conduct a counterattack in the south. Engineers are shown committed to the forces holding the FLOT and assisting in containing the penetration.

Although the corps commander would like to reinforce his attacking division with additional engineers (dotted lines), his mechanized engineers are committed forward. This means the best he can do is provide wheeled engineers to support the attacking division. Due to the time required to disengage and link up, the attacking division would go on the offensive with only its divisional engineers forward—with assistance from corps engineers limited to facilitating movement behind the FLOT and following to keep the LOC open for CCS elements.

ENGINEER BATTLEFIELD LAYOUT
OPERATIONAL LEVEL
CURRENT

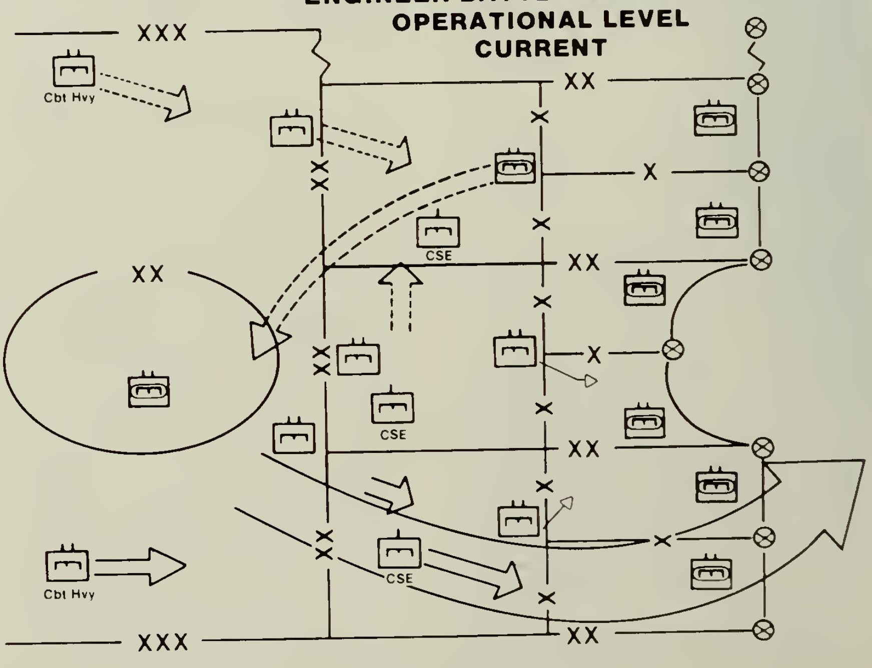


Figure 4

The Solution

E-FORCE solves the problems inherent in our current structure by providing sufficient engineer assets organic to the division and simplifying command and control, communications, maintenance and supply. It gives engineer units the advantages of habitual association with their *go to war* units.

The close combat heavy E-FORCE divisional organization (Figure 5) consists of three 493-man divisional combat engineer battalions and one ribbon bridge company. These battalions have three armored combat engineer companies comprised of two sapper platoons and one assault and barrier platoon. With an end strength of 1,684, it is formed by combining the 893-man divisional engineer battalion with a 790-man corps combat engineer battalion.
gineer battalion.

Figure 6 shows how this organization can be deployed on the battlefield. The division engineer orchestrates the engineer effort throughout

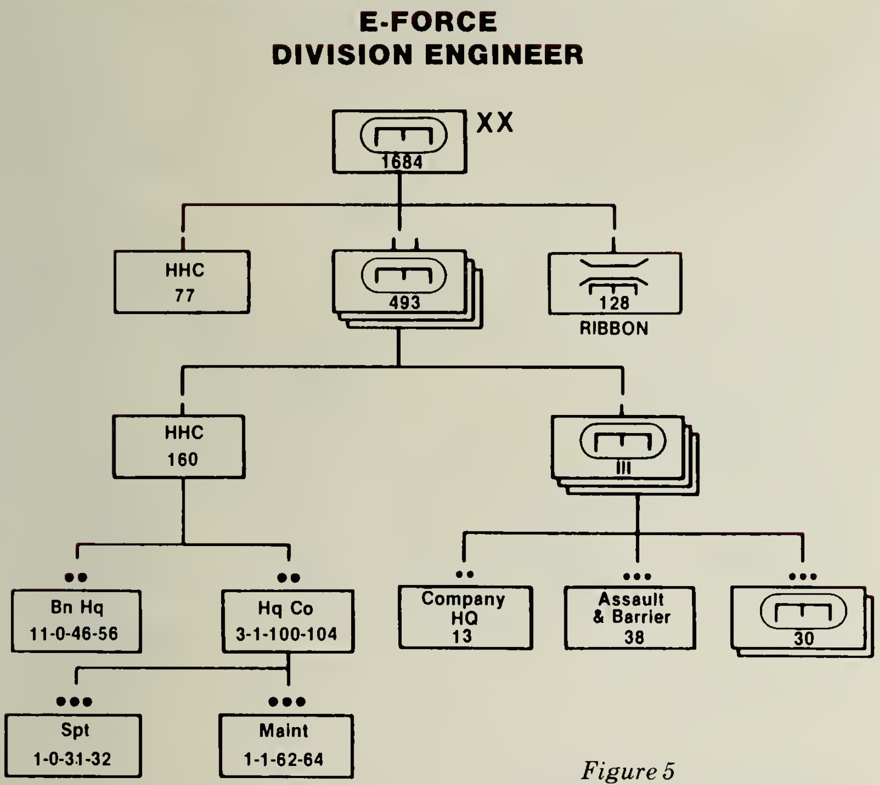


Figure 5

the division area—controlling both organic and corps assets. An engineer battalion is forward with each of the forward deployed brigades. The third divisional engineer battalion provides general support of the entire division rear and moves with the reserve brigade upon commitment.

At task force level, today's overloaded platoon leader is replaced as task force engineer by a company commander. The company commander brings the maneuver task force commander the additional knowledge, expertise, personnel, and equipment necessary to responsively and adequately support the task force. And the engineer platoon leader is given the opportunity to learn his trade under the tutelage of an experienced engineer commander.

The E-FORCE company organizational diagram is shown in Figure 7. The company is organized into two sapper platoons of 30 men each (similiar to today's sapper platoon) and one equipment intensive assault and barrier platoon. This organization provides flexibility for task organizations in support of both offensive and defensive situations.

Each E-FORCE engineer battalion has three of these companies. The battalion organizational diagram is included in Figure 5. The battalion organizational structure parallels that of the combat arms battalions. Maintenance is colocated at battalion level with company teams to support the engineer companies. A support platoon within the HHC will support the engineer companies with POL and Class V (ammunition) resupply—reducing the size of company trains and paralleling armor and mechanized infantry organizations.

The fact that the battalion will operate within a brigade rather than a division area makes these organizational changes possible. By centralizing support assets, we focus the effort of deployed squads, platoons and companies forward. This allows units more time on-site to support the maneuver commander. It is a flexible organization that integrates sufficient assault breaching equipment forward with the maneuver forces—allowing units to deploy rapidly, cross obstacles in stride and maintain the momentum of the attack.

Each maneuver echelon has an engineer element of the commensurate level to support the maneuver commander:

- An engineer company commander supports the task force.
- An engineer battalion commander supports a maneuver brigade.
- A division engineer directs the total engineer effort within the division area and performs advance planning for future operations.

The maneuver commander can expect and receive the same level of

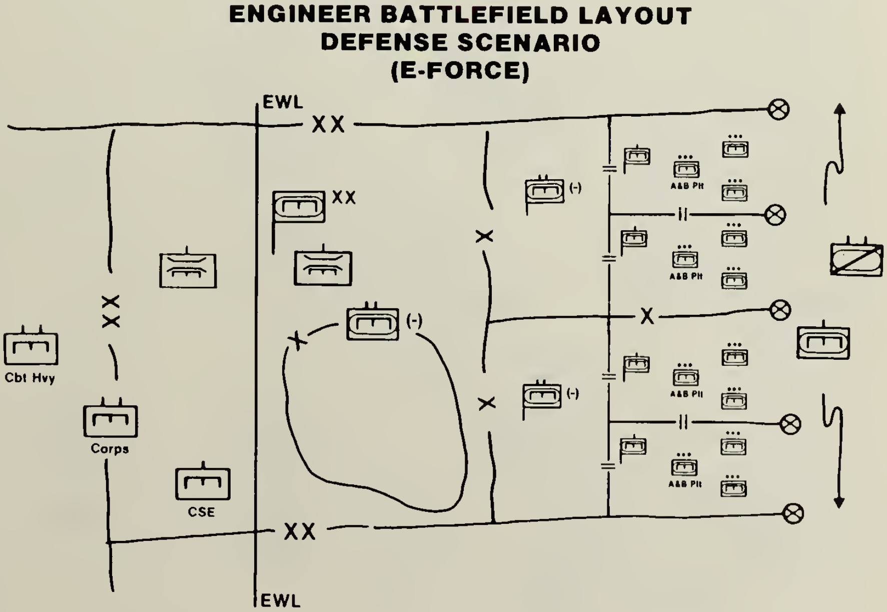


Figure 6

responsiveness throughout his organization.

Communications requirements are simplified. As organic members of the division, engineer units are assured access to CEOIs and COMSEC keying materials. The area of responsibility for each engineer battalion is reduced to a manageable level. DISCOM can be resourced to support the additional engineer assets in the division area. Most important, engineer units can habitually train with their fellow members of the combined arms team.

E-FORCE provides the maneuver commander at corps and division level with dynamic, flexible, responsive engineer support to influence the battle. Figure 8 depicts the Figure 4 scenario under E-FORCE.

E -FORCE
DIV ENGR COMPANY

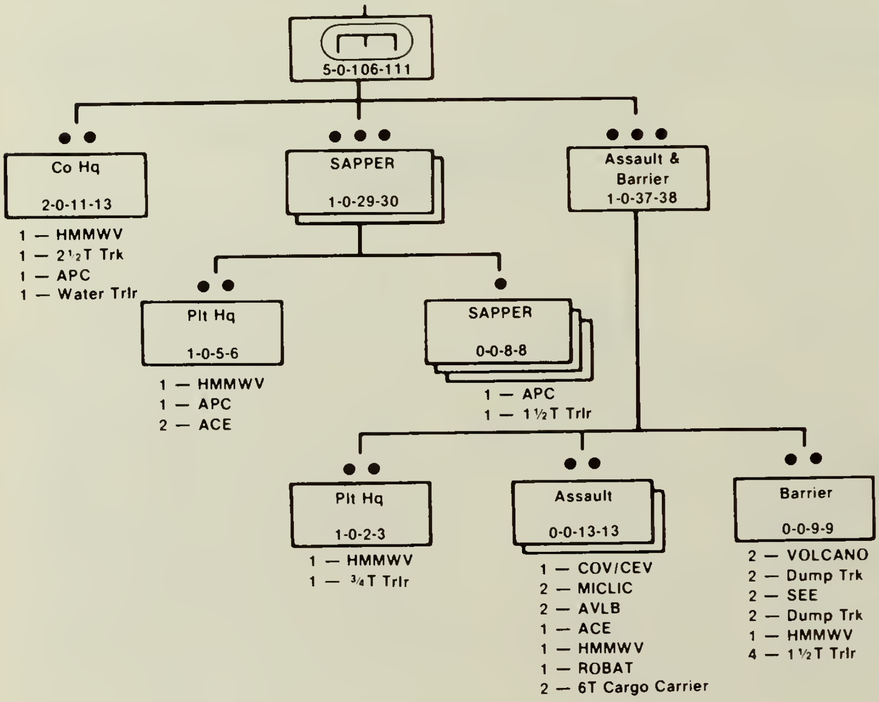


Figure 7

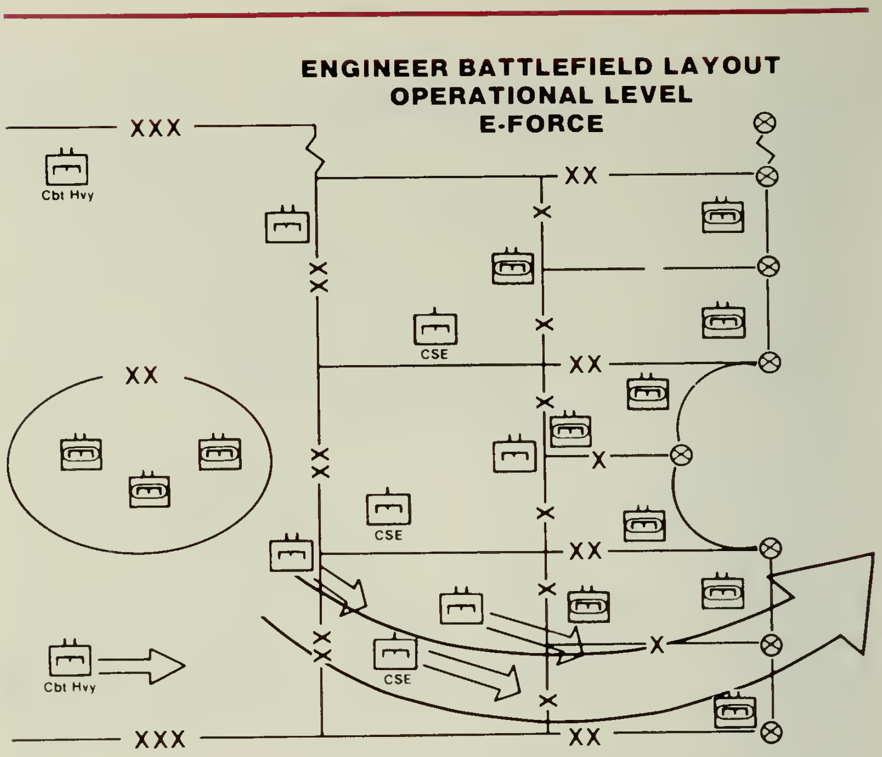


Figure 8

Again, the corps commander must control the FLOT, contain the penetration in the center, and conduct a counterattack in the south. Engineers are again committed to assist in controlling the FLOT and containing the penetration. But this time the attacking division has sufficient engineer assets to support its offensive.

Corps units can still assist in preparing the route of advance to the FLOT, but each attacking brigade has at least one battalion of mechanized combat engineers—soldiers they habitually trained with—who are ready to accompany them into battle.

Concurrent with the reorganization of the divisional engineer support structure, engineer capability in the corps' area will be restructured. Corps capability and flexibility is retained because over 52% of the engineer structure remains at corps.

Figure 9 is an organizational line diagram of the corps sapper battalion. This three-company battalion will replace today's corps combat engineer battalion. Blade-type earthmoving equipment is being added to carry out the rubble clearance and route maintenance tasks expected from high intensity combat in built up areas such as central Europe.

The combat support equipment (CSE) company will also be reorganized to focus on LOC maintenance-type missions and to augment corps sapper battalions with heavy engineer equipment. Figure 10

E-FORCE CORPS SAPPER BATTALION

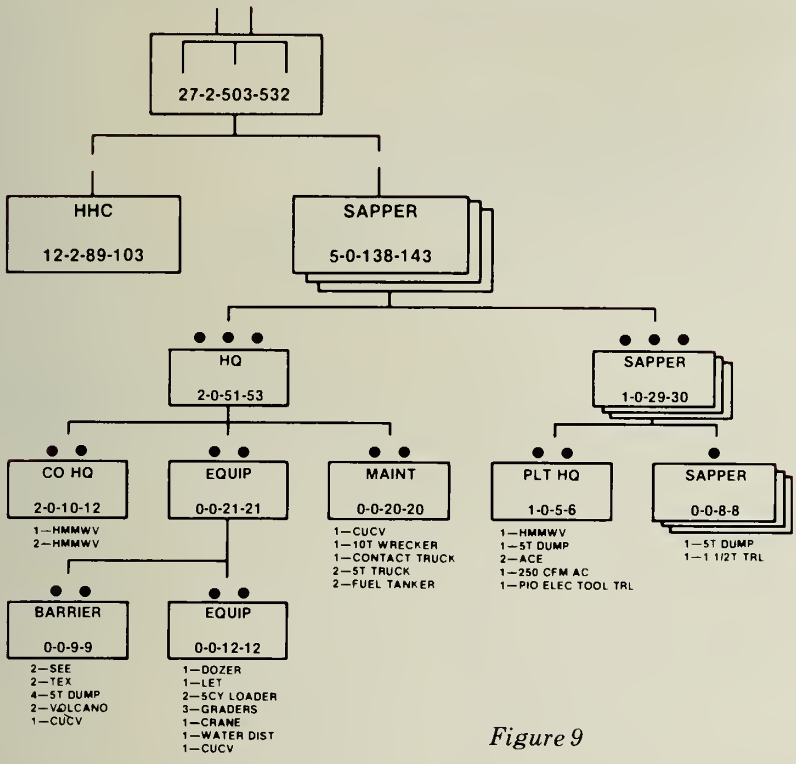


Figure 9

shows the proposed CSE company organization.

The emphasis on LOC maintenance and rubble clearance acknowledges the importance of keeping the corps' lifeline to resupply open and preserving ability to maneuver behind the FLOT. The heavy equipment is also readily available to move forward and supplement the divisional engineers in creating survivability positions and constructing obstacles.

Conclusion

While AirLand Battle doctrine doesn't change the basic combat engineer missions, it places additional emphasis on the dimension of time. To contribute as a combat multiplier and true members of the combined arms team, combat engineers must be able to provide timely, responsive support to the maneuver commander. If, on the other hand, the maneuver commander must wait for his engineers, *fleeting windows of opportunity* on the battlefield are lost.

The current engineer structure is unresponsive to the demands of AirLand Battle. The deficiencies defy genuine efforts to overcome the problems through ad hoc command and control arrangments and task forces. E-FORCE attacks and corrects the deficiencies. Under E-FORCE, the combat engineer is truly an integral member of the combined arms team.

ENGINEER COMPANY
COMBAT SUPPORT EQUIPMENT

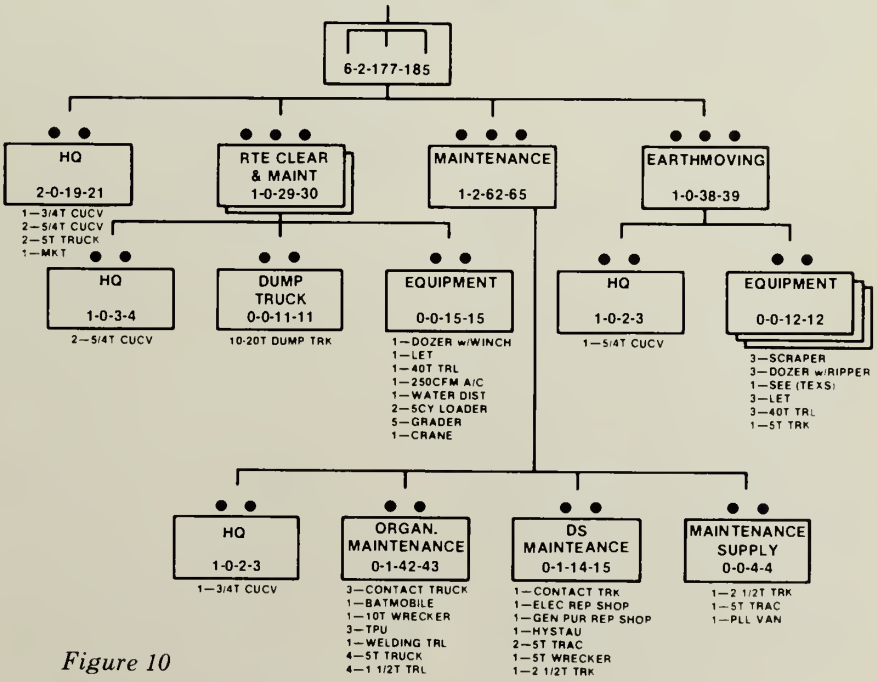


Figure 10

MG Richard S. Kem is commandant of the Engineer School. He has served in armored, corps, combat heavy, and airborne engineer battalions and at both division and corps staff level.

MAJ J. Richard Capka is the S-3 for the Engineer School Brigade at Fort Belvoir. He graduated from the U.S. Military Academy and the Command and General Staff College. He has a master's degree in engineering from the Univesity of California at Berkeley and is a registered professional engineer in Virginia.

MAJ Houng Y. Soo is assigned to the Engineer School Directorate of Combat Developments. He has a bachelor's degree from the Polytechnic Institute of Brooklyn, a master's degree in nuclear engineering from the University of Washington, and is a graduate of the Command and General Staff College. He is a registered professional engineer in Washington.

Combat Heavy Redesign

by LTC Robert L. Herndon

A leaner, more productive, better led, more rationally designed, modern engineer combat battalion (heavy) will soon be fielded. The first unit (not yet selected) will convert in FY 87. New ARTEPs and revised soldier's manuals will be available when the new TOE takes effect.

The redesigned combat heavy will focus on general engineering tasks to the rear of the brigade boundary. The advent of efficient, modern combat engineer equipment such as the ACE, Volcano, TEXS, and COV will enhance the capabilities of divisional and corps battalions and obviate the need for the combat heavy in the brigade area.

However, the battalion will retain limited combat engineering and infantry capabilities and, thus, retains ***combat*** as a descriptor in its title.

Because the *reoriented* combat heavy battalion generally will be located to the rear of the brigade boundary, it is defined by AR 310-25 as a Category II unit. By definition, this opens the entire battalion to women.

Historical Perspective

The Department of the Army approved the new TOE 5-115 in response to concerns that the existing battalion is overloaded.

In 1974, the engineer construction battalion was converted to the combat heavy. The main thrust of this conversion was to put more *tooth* into the Army's general purpose force structure as required by the Nunn Amendment. Studies of the early 1970s engineer slice of the force structure typically referred to the engineer combat battalion as part of the *tail.*

The conversion added combat engineering missions and "infantry operations, when required" to the repertoire of the battalion and changed its name to the engineer combat battalion (heavy). As a result, the battalion was added to the *tooth* portion of the force structure and the Army's *tooth-to-tail* ratio was enhanced.

> **"The engineer combat battalion (heavy) is overloaded. Due to its greater flexibility and utility, planners have committed it to missions from the FCZ to the COMMZ which call for it to perform all combat and general engineering tasks."**
>
> **—Functional Area Assessment Issue 5-7, August 1984**

While the change appeared superficial to some observers, the impact was significant within the battalion. The post-Vietnam soldiers in CMF 51, general engineer, who comprised most of the battalion, were required to learn not only technical constructions skills (carpentry-masonry, structures, plumbing, electrical, and construction equipment operations), but also to master all combat engineering and most light infantry skills.

In support of the installation or MACOM, the battalion performed *construction* tasks during most of the year, but was then evaluated in a field environment, primarily on its *combat* skills. Over the next several years, the CMF 51 NCOs scored lower than their contemporaries on the SQT and performance evaluations, and the combat heavy battalions *appeared* less trained during field evaluations to ARTEP standards.

The combat heavy had become the decathlete of battalions. It was required to perform all general engineer tasks of the old construction battalion, plus all combat engineering tasks of the combat engineer battalion, and to be prepared to conduct all light infantry operations of an infantry battalion. It was everything to everybody. It was overloaded!

Redesign Process

In 1984, through *Functional Area Assessment Issue 5-7*, the Army leadership recognized the problem and tasked the Engineer School to evaluate the employment of the combat heavy and to consider redesign, if appropriate.

Engineer Combat Battalion Heavy
TOE 05115L000

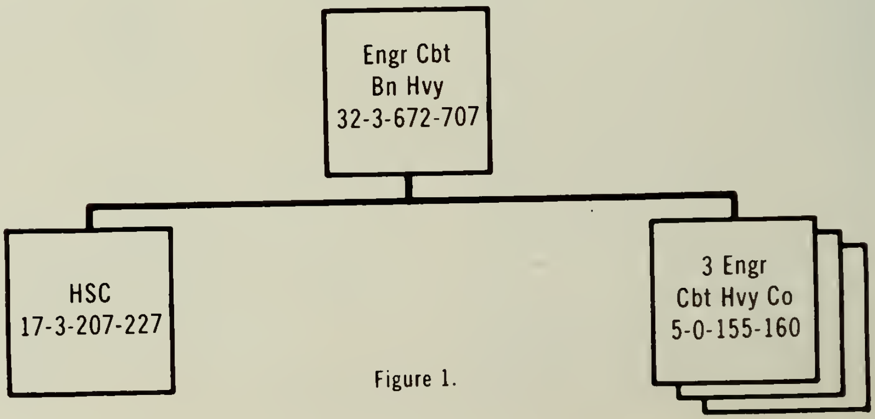


Figure 1.

Headquarters and Support Company (HSC)
Engineer Combat Battalion Heavy
TOE 05116L000

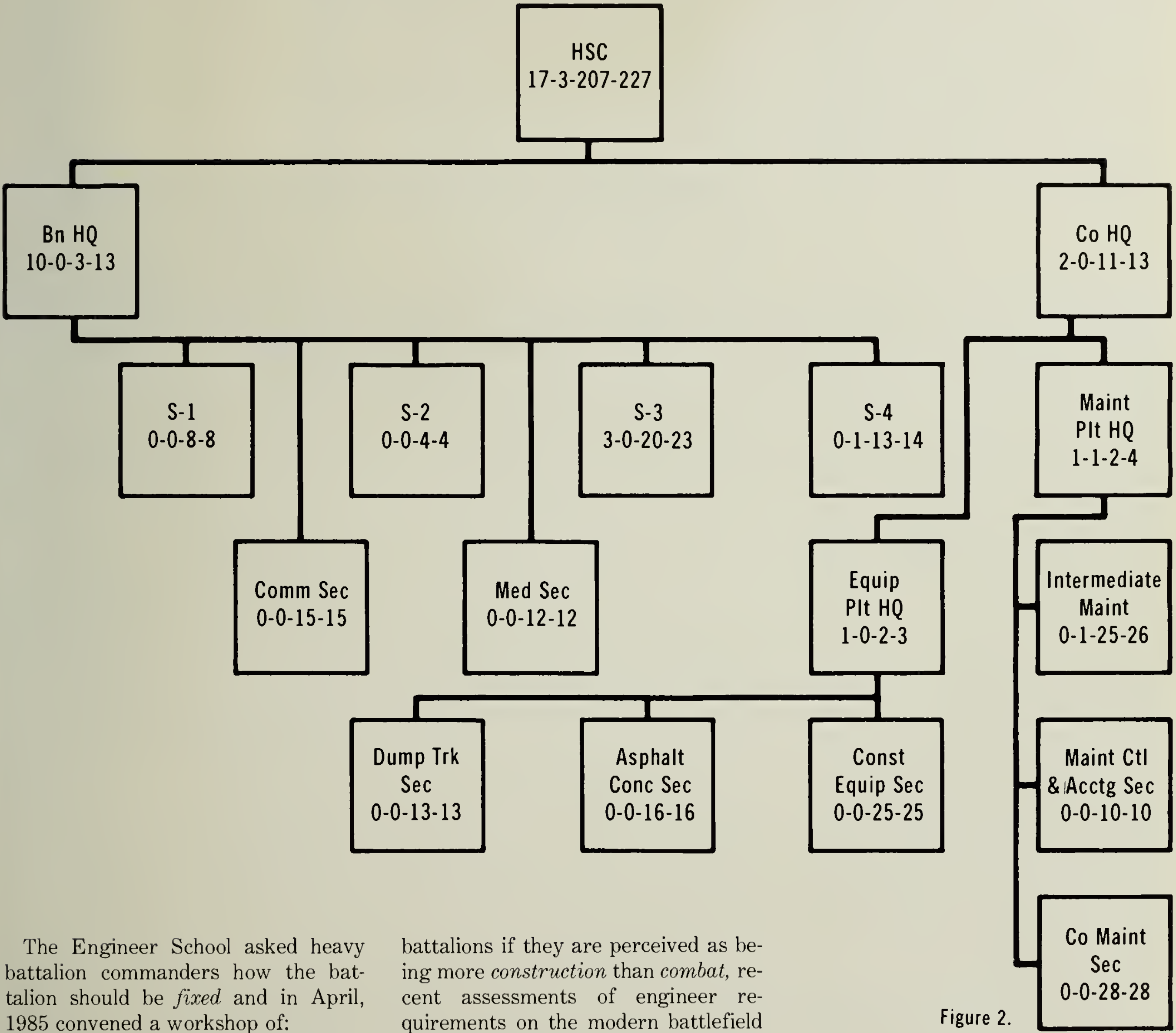


Figure 2.

The Engineer School asked heavy battalion commanders how the battalion should be *fixed* and in April, 1985 convened a workshop of:

- Active Army and reserve component group and battalion commanders,
- Command sergeants major, including the Corps of Engineers Command Sergeant Major,
- Corps and MACOM engineers,
- Corps of Engineers staff officers,
- Engineer School representatives.

The result was a major reorientation of the battalion's mission and capabilities statements and a redesign of the battalion. The changes were not developed in a vacuum.

The mission of the combat heavy was rationalized considering all engineering requirements on the AirLand battlefield. Although many engineers feel a visceral fear of losing combat heavy battalions if they are perceived as being more *construction* than *combat*, recent assessments of engineer requirements on the modern battlefield fully justify the existence of the combat heavy to execute general engineering in the RCZ and COMMZ.

The necessity within the force structure for combat heavy engineer battalions to perform construction tasks is now accepted. Therefore, the mission was rationalized without constraints or fears that a more realistic mission statement might result in eliminating the combat heavy battalions from the force.

Revised Mission and Capabilities

The revised mission and capabilities statements greatly relieve the battalion overload and provide a more rational approach to the vast engineer requirements on the battlefield. The redesigned combat heavy will operate from the division rear through the COMMZ.

Because the battalion will be conducting operations to the rear of the brigade boundary, the requirement "*to perform infantry combat missions, when required*" was revised to read "*to perform rear area security operations to include fighting as infantry, when required.*" This change deletes many light infantry tasks from the battalion's ARTEP.

A major deletion from the capabilities of the battalion was the elimination of minefield emplacement and clearing tasks. Mine detection equipment has been retained in the battalion, and routine minesweeps remain an integral part of construction and reconnaissance operations.

The hasty protective mine task also remains in the battalion's repertoire as it is a common soldier task. However, emplacement of deliberate and point minefields and breaching of minefields are brigade area tasks and, therefore, out of the work area of the combat heavy.

When minefields are found to the rear of the brigade boundary (opposing forces' FASCAM or bypassed minefields), it is postulated that the timing of the removal will not be so urgent and frequent allowing combat engineer battalions to be tasked from corps assets to execute these missions.

Reorientation of the combat heavy's mission greatly relieves *overloading* of the battalion. It also provides a rational architectural approach to support the vast engineer requirements of the AirLand battlefield.

Engineer Company
Engineer Combat Battalion Heavy
TOE 05117L000

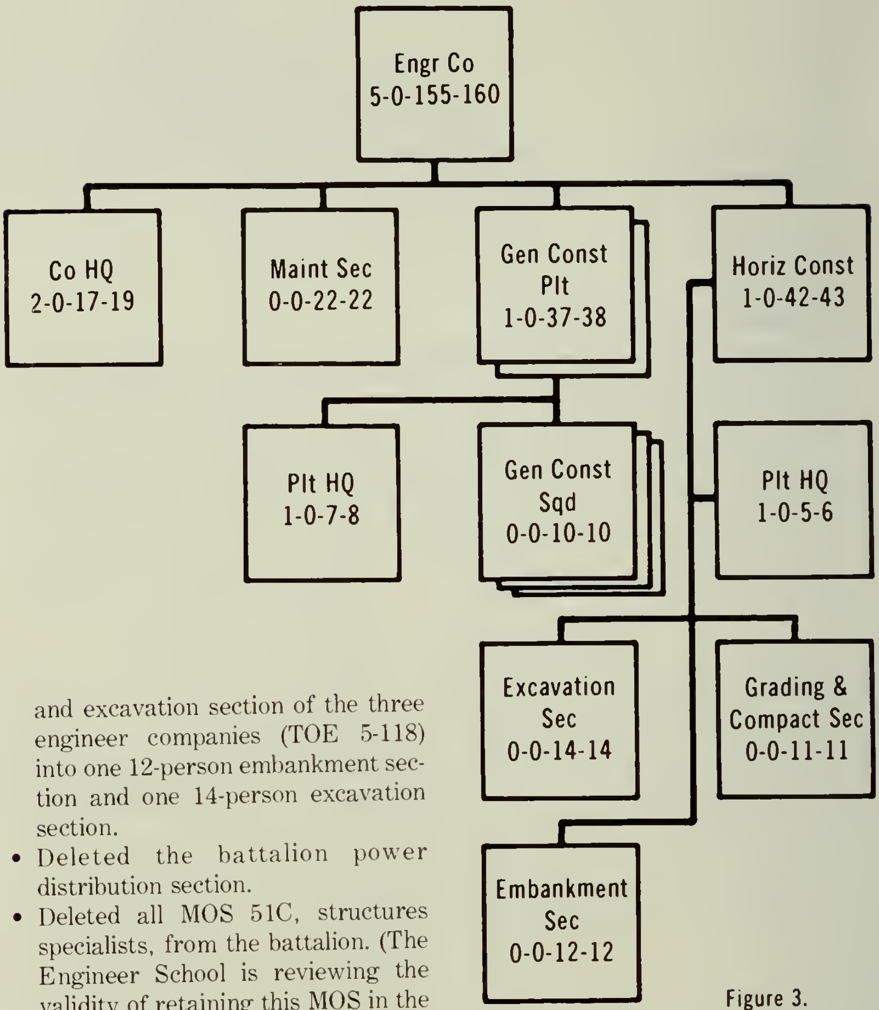


Figure 3.

Organization Redesign

The internal organization of the combat heavy was scrutinized. Every position and item of equipment was examined under the microscope of mission essentiality, doctrine, proper skill utilization and rank structure, and modern construction practices. Again, there were no *sacred cows*. The result was a lean, modern, more productive battalion designed for wartime missions, not peacetime construction.

Substantive changes—

- Reduced the battalion level 1 TOE strength from 796 to 707, a savings of 89 spaces per battalion.
- Established requirements for modern engineer construction equipment such as interchangeable drum vibratory rollers and extending boom excavators.
- Deleted the engineer equipment and maintenance company (TOE 5-117; A Company) and rolled the unique engineer equipment and engineer direct support maintenance into a redesigned headquarters and *support* company (TOE 5-116), increasing the size from 116 to 227; large, but within the command capability of a captain.
- Reduced the size of the general construction squad from 12 to 10.
- Modified the 20-person embankment and excavation section of the three engineer companies (TOE 5-118) into one 12-person embankment section and one 14-person excavation section.
- Deleted the battalion power distribution section.
- Deleted all MOS 51C, structures specialists, from the battalion. (The Engineer School is reviewing the validity of retaining this MOS in the force structure.)
- Consolidated the concrete mobiles into the asphalt-concrete section of the headquarters and support company.
- Consolidated the medium equipment transporters and 20-ton dump trucks requiring 64C, heavy vehicle drivers, into a separate *dump truck section* in the headquarters and support company.
- Deleted obsolete and unnecessary equipment such as ditching machines, telephone maintenance trucks, chemical and biological shelter systems, and all hot-mix asphalt equipment (two bituminous distributors remain).

Organizational diagrams of the redesigned battalion, headquarters and support company, and engineer company are shown in Figures 1, 2 and 3. Figure 4 compares the redesigned battalion to the existing battalion.

Conclusion

Some confusion is inevitable whenever a new TOE is fielded. Temporary modifications will be made until new equipment is procured. As the Army embarks on this shakedown, keep in mind that this redesign grew out of a detailed evaluation by experienced field and staff engineer officers and NCOs. The goal was a lean, modernized, more productive battalion. The redesigned engineer combat battalion (heavy) meets that goal.

The new combat heavy is not a compromise based on politically expedient *tooth-to-tail* decisions, nor is it change for the sake of change, nor a manpower savings drill. The combat heavy redesign reflects a realistic look at wartime engineer requirements. The combination of the redesigned combat

Comparison:	Current ECB(H)	Redesigned ECB(H)
Strength	796	707
Officers	32	32
Warrant officers	9	3
Enlisted	757	672
General construction	62%	53%
Earthmoving	38%	46%
Leader/led	.199	.209

Figure 4.

heavy, corps combat engineer, and divisional engineer battalions provides a coherent package of engineer support to the AirLand battlefield.

LTC Robert L. Herndon commanded the 802d Engineer Battalion (CBT)(HVY) in Korea plus construction and divisional engineer companies in Vietnam. He has also served in Germany, Panama, and CONUS. He served in HQDA, ODCSOPS Training Directorate from 1978 to 1982 where he guided the National Training Center from concept formulation to establishment.

He is currently attending Harvard University as a senior fellow in national security. He has a bachelor's degree in civil engineering from the University of Texas at Austin, a master's degree in construction management from Texas A&M University, and a master's degree in management from MIT. He is a registered professional engineer in Texas.

Introducing: The Sapper

An entirely new breed of soldier is emerging within the light and heavy divisions—*the combat engineer sapper.* Equipped with unique skills and abilities critical to AirLand Battle, he is a creation of Division '86, the Army of Excellence and the restructuring of the divisional engineer battalion.

Today's sapper is a soldier trained to attack engineer problems with the speed necessary to support AirLand Battle and mobile armor warfare . . . to get the job done with whatever is immediately at hand . . . to seek quick and dirty rather than elegant solutions . . . to operate and survive under fire. Initiative, ingenuity and agility are his stock in trade.

Traditionally, the combat engineer built field fortifications and deliberately breached routes through complex obstacles and minefields. He worked under fire, relying on manual labor, and occasionally aided by unprotected heavy equipment. The engineer missions remain virtually the same. But tactics and doctrine have changed—rendering slow, deliberate methods obsolete. AirLand Battle puts speed and ingenuity at a premium.

Who is a Sapper?

The sapper's hallmark isn't his organization or his equipment; it's his frame of mind. A sapper is an engineer who survives on his wits and his grit . . . an innovator who turns terrain and time to advantage by exploiting his situation and surroundings with the quick and dirty solution to whatever problem is at hand. His *can do, essayons* ingenuity are what make him essential in support of both the light and heavy force.

The Light Sapper

The light sapper supports the light infantry team in deep thrust operations behind enemy lines and in defense of mountains, jungles, urban environments and other terrain that demand his unique talents. He relies on airmobile insertions, stealth and night movements on foot to achieve mobility. Equipped only with what he can carry, his single greatest assest is his *sapper spirit*—his ability to improvise.

The Heavy Sapper

The heavy sapper has more equipment to do his job—not enough . . . never enough . . . but more than the light. An APC is his conveyance, workroom, bunker and fighting platform. He is armed with an array of demolition materials and mines. But his focus is not on his equipment—it's on the mission: *How to get it done with what he's got!* Like the light sapper, he depends upon his own resourcefulness—his *sapper spirit*—to sustain the momentum of the attack.

The modern 12B engineer assigned to a corps or divisional battalion resembles his 11B infantry counterpart in many ways—handling many of the same basic tasks. The difference is a matter of emphasis—the 12B specializes in the engineer-unique; the 11B in the infantry-unique. While sappers do not usually fight as infantry in the macro sense as a battalion or a company, they fight as platoons within their task forces when the tactical situation requires. But the sapper is audacity personified—a new breed of combat engineer honed for the demands of AirLand Battle, a true combat multiplier.

Equipment Roundup

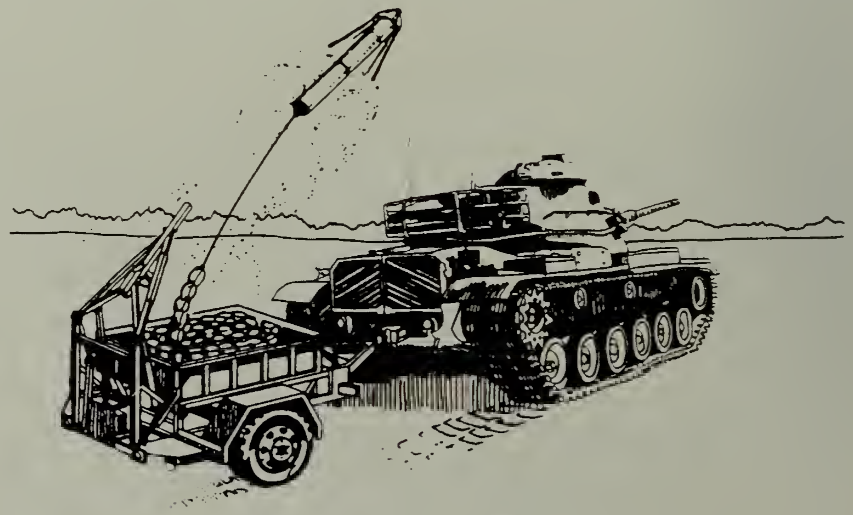
by CPT Jeff Engbrecht

The Volcano

The Volcano—a scatterable mine delivery system—rapidly dispenses 960 antitank and antipersonnel mines from the UH-60 helicopter and a variety of ground vehicles. Responsiveness is limited only by the crew's ability to load the dispenser (about 15 minutes) and vehicle speed. Air Volcano dispenses its payload in 15 seconds at 120 knots.

Volcano delays the enemy, isolates the battlefield, and reinforces friendly fires in both the offense and defense. It will replace the M56 as the standard helicopter mine dispensing system and GEMSS as the ground delivery system for heavy and light forces.

The Volcano system was type classified for procurement in fall FY 86. Helicopter capability will be available to the 7th and 9th Infantry Divisions in FY 87. Volcano will be available to other aviation and engineer units in 1992.



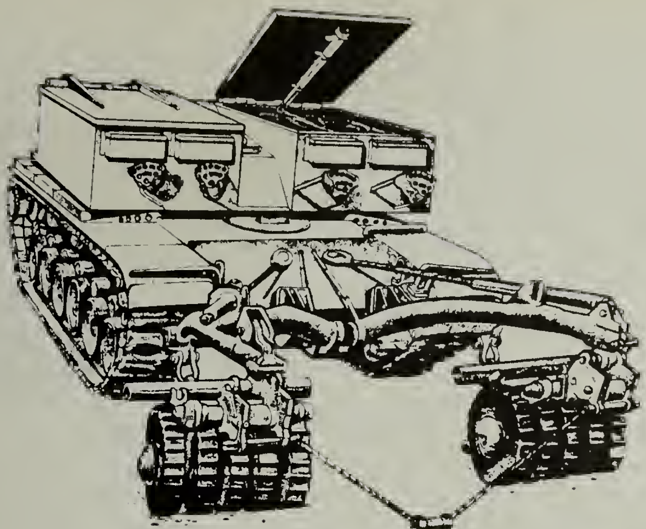
The M58A1 Mine Clearing Line Charge (MICLIC)

The MICLIC–a rocket-projected explosive line charge–provides close-in breaching capability. When detonated, the MICLIC clears a lane 5 × 100 meters from a stand-off distance of 50 meters. A second MICLIC can be fired from the breached lane if a longer breach is required.

MICLIC will be used in response to minefield breaching requirements identified by the maneuver unit. A combat prime mover tows the trailer to the point of the breach where the line charge is prepared by an engineer firing squad. The trailer is reusable and can be dropped off at a preselected location firing for recovery by support elements.

Fielding is scheduled for fall FY 86. Three MICLIC trailers will be issued to each engineer company in airborne, air assault, high tech light division, and corps support roles. Two MICLIC trailers will be allocated to heavy division engineer companies equipped with the ROBAT.

The Robotic Obstacle Breaching Assault Tank (ROBAT)

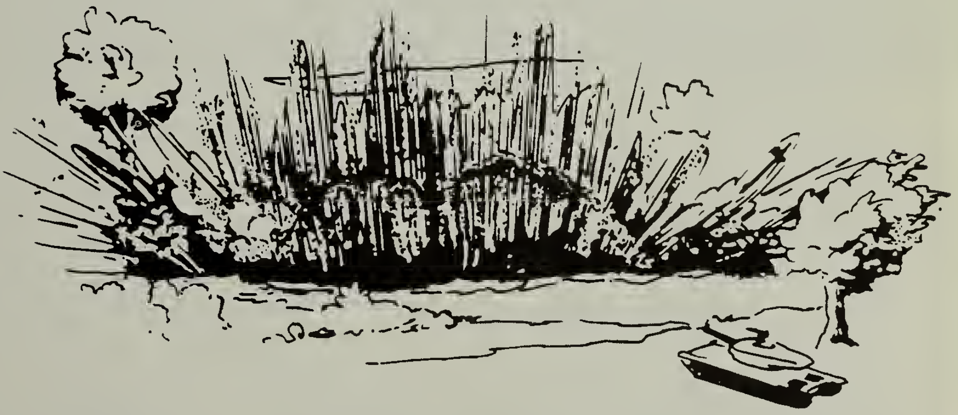


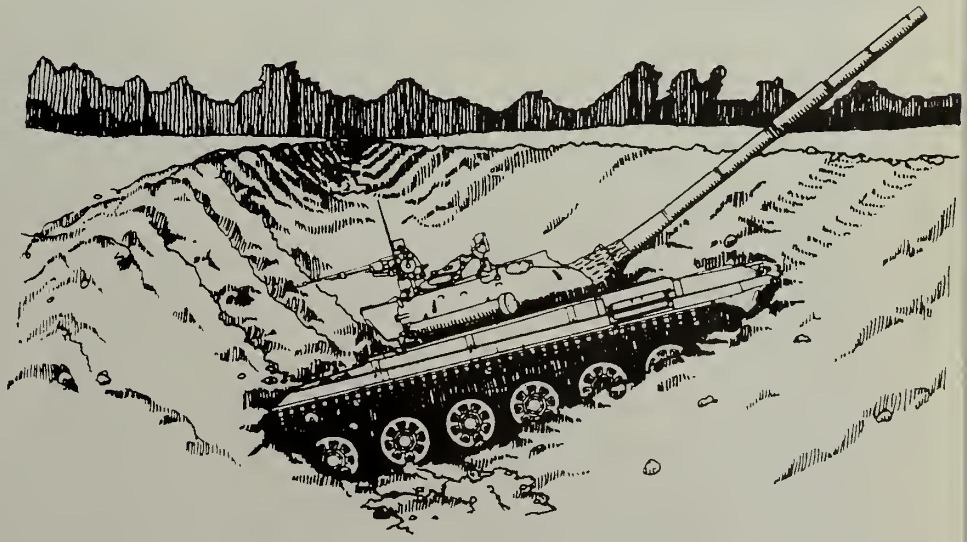
ROBAT breaches minefields by remote control. An operator outside the vehicle directs ROBAT into the minefield where it fires a line charge and marks the cleared lane. Depending upon the tactical situation, ROBAT can also be operated manually from inside. Eventually, computer technology will fully automate ROBAT's breaching capability.

Engineers will operate ROBAT in support of the combined arms team. ROBAT consists of an improved M60 chassis, a track-width mine roller or plow, two mine clearing line charges, and a marking system. When a minefield is detected, ROBAT will move forward from approximately one terrain feature behind maneuver forces to breach.

An accelerated development program is proceeding and a prototype has been produced. However, a fielding date has not been set because of budget constraints.

The Tactical Explosive System (TEXS)





TEXS will consist of a liquid blasting agent, mixing and pumping equipment, and an entrenching attachment mounted on a small emplacement excavator (SEE).

Engineers will employ the TEXS in covering force, main battle and rear areas. TEXS will:

- Create long antitank ditches or crater roads using pre-emplaced or rapidly emplaced pipe.
- Destroy bridges.
- Create rubble obstacles in urban areas.
- Reduce obstacles to increase mobility.
- Create defilade positions.
- Perform general demolition tasks.

First developed as an antitank ditching explosive, TEXS is now finding other uses such as deliberate breaching of minefields. The lower detonation velocity of the TEXS explosive produces blast pressures that last longer than such high explosives as C-4 or TNT. This allows the mechanical spring systems of pressure-activated mines more time to respond to an applied blast pressure.

Because the TEXS blasting agent is nonexplosive until it is mixed, it offers a tremendous advantage over conventional explosives in terms of handling and storage, especially in zones subject to enemy fire.

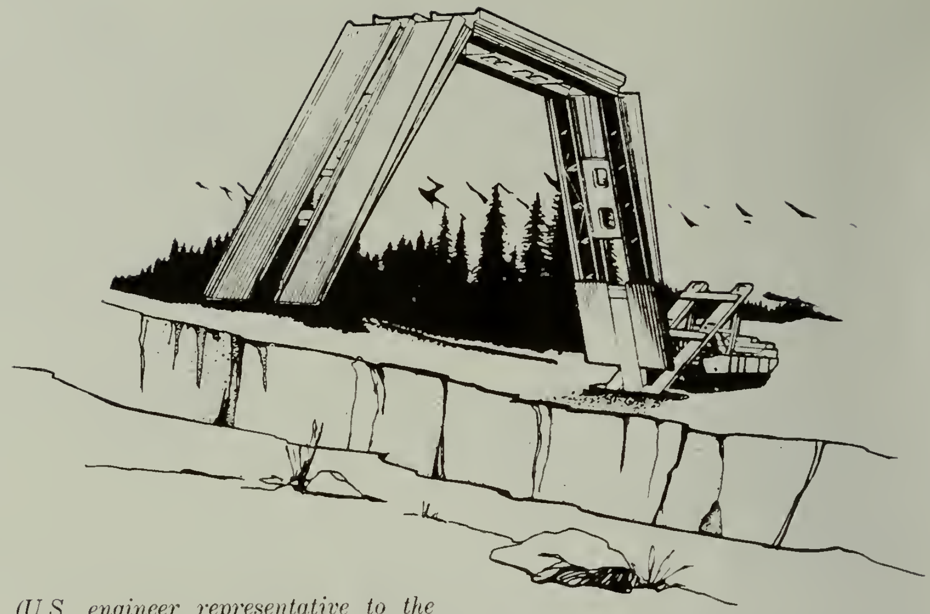
Development is underway. The Waterways Experiment Station (WES) is testing the liquid blasting agent and the mixing, pumping and emplacement hardware.

The Heavy Assault Bridge (HAB)

The HAB will be a standard tank chassis modified to transport, launch, and retrieve a military load class (MLC) 70 bridge that spans 32 meters. It will also launch the current 60-foot armored vehicle launched bridge (AVLB).

The HAB will be used by heavy division forward elements and emplaced similarly to the AVLB. The assault carrier can launch the bridge without exposing the crew to enemy fire and retrieve the bridge at either end.

The HAB is in advanced development. Fielding is slated for FY 92. It will be distributed among heavy division engineer units.



CPT Jeff Engbrecht is assigned to the Force Design Branch of the Directorate of Combat Developments, USAES. He has served as platoon leader of C Company of the 78th Engineer Battalion (U.S. engineer representative to the Allied Command Europe, Mobile Force) and assistant S-3 of the 78th Engineer Battalion in Ettlingen, Germany.

He is an EOAC graduate and has a degree in industrial engineering from Rochester Institute of Technology.

Recent ETL Publications

Current Engineer Topographic Laboratories projects involve terrain analysis, mapping, automated cartography, image processing, surveying, weapon guidance, and robotics.

Copies of the following ETL technical reports are available at a nominal cost from the National Technical Information Service, 5285 Port Royal Road, Springfield, VA, 22161, or through the Defense Technical Information Center, Cameron Station, Alexandria, VA, 22314-6145. When ordering publications from these organizations, please use the AD numbers listed.

Development of Electronic Control for the Superconducting Gravity Gradiometer, September 1985, AD-A160 641.

Electronic Feedback Control of Mass-Spring Systems, September 1985, AD-A160 691.

Extended Area Exit Pupil Viewer, August 1985, AD-A159 364.

Third-Order Co-occurence Texture Analysis Applied to Samples of High Resolution Synthetic Aperture Radar Imagery, August 1985, AD-A160 640.

Software Conversion of DMA Standard Linear Format (SLF) to Intergraph Corporation Standard Interchange Format (SIF), July 1985, AD-A161 086.

Bibliography of In-House and Contract Reports, Supplement 11, May 1985, AD-A160 607.

A New Large-Scale, High-Resolution Multicolor Software Display Concept, March 1985, AD-A155 404.

Alternative Theories of Inference in Expert Systems for Image Analysis, February 1985, AD-A153 649.

Further Study of Digital Matching of Dissimilar Images, February 1985, AD-A153 112.

System Analysis of a Field Army Topographic Support System, February 1985, AD-A153 318.

Evidential Reasoning in Expert Systems for Image Analysis, February 1985, AD-A153 379.

Video Discs for Map Displays, June 1984, AD-A149 646.

Application of Artificial Intelligence to Radar Image Understanding, February 1985, AD-A152 519.

Analysis of Edge Detection Algorithms on DIAL, January 1985, AD-A156 735.

Defense Mapping Agency Raster-to-Vector Benchmark Testing, December 1984, AD-A154 152.

Defense Mapping Agency Raster-to-Vector Analysis, November 1984, AD-A154 153.

Application of Hierarchical Data Structures to Geographical Information Systems, Phase III, October 1984, AD-A152 169.

Cultural Data Base Implementation Study and Computer-Aided Scene Modeling Users Manual, October 1984, AD-A154 232.

Hexagonal Data Base Study, Phase II, October 1984, AD-A150 176.

Feature Extraction Assessment Study, Final Report, October 1984, AD-A150 189.

Interactive Digital Image Processing for Terrain Data Extraction, Phase 5, September 1984, AD-A148 580.

Terrain Analysis Procedural Guide for Built-Up Areas, April 1984, AD-A142 918.

Terrain Analysis Procedural Guide for Surface Configuration, March 1984, AD-A147 637.

Obstacles—

Engineers and Maneuver Forces Need Common Terms

Point

(continued from inside front cover)

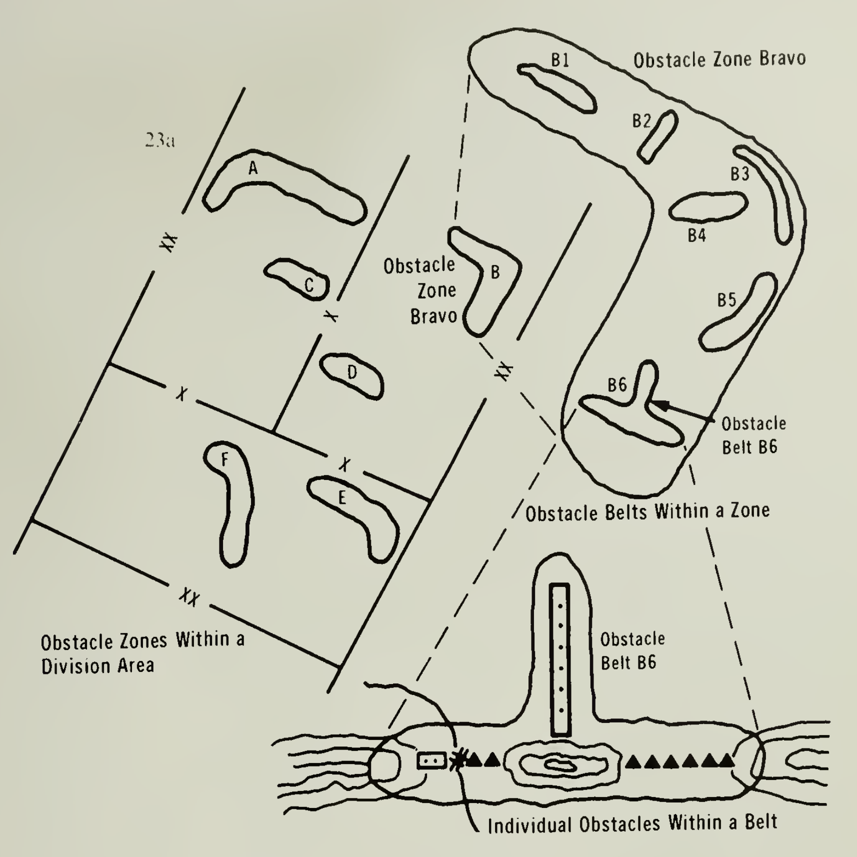


Figure 1. Use of Obstacle Belts and Zones

The Proposal

Clearly, a set of obstacle control measures is needed to allow the commander at each level to concentrate the obstacle effort and provide onetime guidance that accurately conveys his intent. The terms obstacle zone and obstacle belt, defined as follows and illustrated in Figure 1, satisfy the need:

- ***Obstacle Zone***—An area in which obstacles are to be placed. It may be restrictive (for example, limiting obstacles to an area of difficult terrain along a river). It could be nonrestrictive, encompassing most of the area of operations. Used in a restrictive manner, designation of obstacle zones would leave other areas obstacle free to facilitate support operations and maneuver. It focuses the obstacle effort (a limited resource) in areas where reinforcement of the terrain plays a definite role in the commander's concept of the operation.
- ***Obstacle Belt***—A grouping of existing and reinforcing obstacles that serve a common purpose (such as to block an avenue of approach, seal a flank or channelize an enemy unit into an engagement area). At brigade and task force level, the designation of obstacle belts would serve the same purpose as obstacle zones.

The method for using the terms to control the engineer effort would allow appropriate input at each level:

- A division would designate obstacle zones. No obstacles could be emplaced outside the zones other than hasty protective minefields and division-controlled FASCAM.
- A brigade would, in turn, designate obstacle belts (normally oriented on company-sized avenues of approach). These belts would be placed to allow for support operations and maneuver. No obstacles could be placed outside the belts other than hasty protective minefields and brigade-controlled FASCAM.
- At task force level, individual obstacles would be planned and emplaced within the belts. Specific obstacle sitings would be determined by the task force or overwatch team as appropriate.

Commanders at any level could request that belts or zones be added or extended to more closely support their plans. They could also direct that specific obstacles be emplaced and/or that execution authority be retained at any level.

This would allow the division commander to focus the engineer effort within his area of operations with onetime guidance and retain flexibility in his maneuver planning. He and his division engineer could discuss the location of obstacle zones rather than that of numerous individual obstacles. Any specific obstacles discussed would be limited to those that were critical to the division's mission and would, therefore, become directed targets.

At brigade level, the use of belts not only would focus the countermobility effort; it would direct attention to:

- Areas where the commander wants to defeat the enemy,
- An exposed flank,
- An economy of force sector.

The brigade engineer would plot targets in the belts he had developed with the S-3 in order to make generalized logistics plans. The selection and location of the actual targets would be up to the task force and team commanders.

At the task force level, the S-3 and the engineer would have clear constraints within which to implement the brigade commander's concept. Time would not be wasted on target reconnaissance, planning and resources for obstacles outside the belts. The task force engineer's already difficult job would be simplified.

Conclusion

My intention is not to add two esoteric engineer terms to a cumbersome military vocabulary. We need a common language that allows the maneuver commander to convey his engineer concerns to subordinate commanders. The proposed concept would let the

(continued on page 43)

Photo essay by CPT John Florence

Engineers built targets for live-fire ranges, purified water, drilled exploratory water wells, and conducted surveying operations in the debilitating desert heat and blowing sands of Bright Star '85.

Headquartered at Cairo West, Egypt, the engineers worked under the umbrella of the 416th Engineer Command. All elements were commanded by the Third U.S. Army which becomes U.S. Army Central Command when deployed.

Left, A surveyor from the 82nd Engineer Company, Fort Belvoir, places equipment. Top, SSG Martin Martinez, NCOIC of the 26th Engineer Detachment, Fort Campbell, checks a 20,000-gallon bladder of purified drinking water. Right, SP4 Gary Edwards, 38th Engineer Well Drilling Detachment, Fort Bragg, operates a drilling rig at Gabel Homza. Bottom, an engineer from the 82nd takes readings during surveying operations.

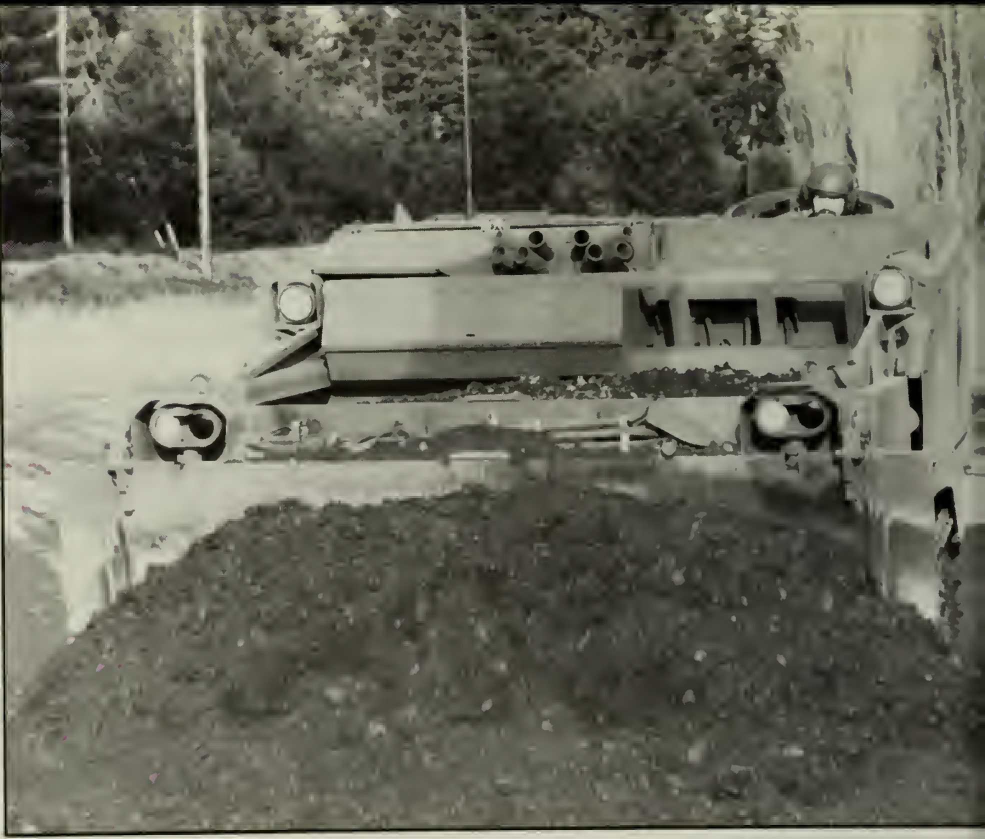
Bright

Star '85

the M9 ACE

Rugged, Responsive and Ready for AirLand Battle

by Victoria McAllister



This summer the Army will accept bids to begin production of the M9 Armored Combat Earthmover (ACE) — a $45.7 million congressional authorization to begin buying 22 M9s in FY 86. The Army Systems Acquisition Review Council chaired by the Vice Chief of Staff and the Under Secretary of the Army has agreed to procure 580 M9s over the next 6 years.

The 14 initial production models that were used during strategic and tactical mobility evaluations in 1985 will be fielded this year:

- Seven to the 7th Infantry Division for light infantry use,
- Four to TRADOC to develop instructional programs and train training teams,
- Three to AMC for ongoing tests.

In 1988, the 9th Infantry Division (motorized) is scheduled to receive 18 of the 22 M9s that will be built under the FY 86 contract. The remainder will go to TRADOC and AMC.

As production proceeds through 1991, the priority for distribution will be first to forward deployed division engineer battalions and armored cavalry regiments and to TRADOC, and finally to selected light forces and the remainder of the forward deployed heavy force.

The M9 gives combat engineers an earthmoving system that keeps pace with lead elements at a time when AirLand Battle challenges engineers to be responsive over greater distances in less time.

The M9 is far more versatile than the bulldozer tractor/trailor system it replaces. Functionally, it is a rugged combat vehicle that brings protected earthmoving capability to the forward brigade area. In addition to digging at a rate comparable to the D7, the M9 can haul and place fill, transport up to 200 cubic feet of cargo, winch, and tow. It is able to negotiate slopes up to 60% and side slopes up to 40%.

Its mobility improvements over the D7 are significant. It moves cross-country and can achieve road speeds of up to 30 miles per hour. It swims at 3 miles per hour in a current of 1.5 meters per second. The M9 can be air transported by a C-130, C-141 or C-5A cargo plane compared with the D7 which requires a C-5A. This strategic mobility improvement is especially important for our light forces.

The M9 is equipped with a smoke grenade launch system; and its armor protects its driver from chemical and biological agents, small arms fire, and artillery fragments. A radio makes it easy to dispatch the M9 to new positions by allowing contact with an engineer platoon or supported manuever force's communications net.

On the offense the M9 prepares crossing sites, breaches antitank ditches and clears rubble from attack routes to sustain the momentum. In the defense, it digs fighting positions for weapons systems and assists in shaping terrain to meet the commander's intent by digging antitank ditches and helping construct obstacles.

How valuable is the M9 ACE to the combined arms team?

While performing on a par with the D7 in work productivity (90% digging capability) and reliability, the M9 during Fort Hood tests demonstrated it exceeds the D7 in mobility, responsiveness and survivability.

During the FTX phase of the evaluations conducted at Fort Hood in 1985, an M9-supported platoon performed with a D7 tractor/trailer system-supported platoon in head-to-head competition.

At the Engineer Commanders' Training Conference in November 1985, MG Kem described the results:

"For example, during a deliberate attack — a run of the western corridor on the second of the 5-day FTX — the tank-mechanized infantry task force conducted a forward passage through two points along Elijah Road, continued north across Cowhouse Creek, then attacked to seize the objective on

Manning Mountain. There were two teams, each with its own engineer platoon . . . one supported by M9s; the other by D7 dozer systems.

"Crossing the line of departure, they immediately met complex obstacles. The M9 breached the antitank ditch in 3 to 7 minutes and moved on to the next obstacle line at Cowhouse Creek. Meanwhile, the D7 system didn't get there for 1½ to 2 hours. Consequently, the D7-supported task force moved over to use the M9 breaches and moved on to the next phase line. Because of their inability to follow the tank-infantry force cross-country, the D7s were sent over a nearby (out of the maneuver box) asphalt road so they could continue to move.

"At Cowhouse Creek . . . the M9 got its task force through the obstacle system. Once again the D7 was unable to close with the obstacle system; and its task force crossed using AVLBs, CEVs and borrowed M9s.

"The task force moved on up to Manning Mountain — the objective! The roads were cut so the M1s could not get up the mountain. The M9s backed around and filled in; the M1s went on up and achieved the objective. The D7 system never completed the mission and the team it supported never completed its assault on the objective . . . mission failure due to the D7.

"There were six different tasks on the way up. The M9 accomplished six out of six; the D7 accomplished one out of six."

The results come at a time when National Training Center experience — where the combined arms team performs together rather than simulates — is again teaching the Army the value of the combat engineer on the battlefield. In deep battle, the onus is on the combat engineers to maintain the ground forces' ability to maneuver — to get them to the right place at the right time. But equipped with the D7, the engineers are too slow and cumbersome to be counted upon.

The missions haven't changed:

- *Mobility* — remove obstacles, breach minefields, cross gaps in stride and under fire.
- *Countermobility* — construct more fighting and protective positions faster.
- *Survivability* — emplace obstacles and minefields rapidly.

However, the windows of opportunity when the manuever commander must act decisively have narrowed. Engineers are challenged to perform the same tasks over greater distances in less time. The M9 met the challenge.

A maneuver commander at the Fort Hood FTX summed up the improvement. *"The engineers,"* he said, *"are finally going to get rid of their ball and chain."*

Victoria McAllister is Features Editor of ENGINEER Magazine.

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Hotline Q & A

Q. When will Army National Guard engineers be allowed to participate with combined arms at the National Training Center?

A. National Guard engineers are already allowed to participate with combined arms at the National Training Center. National Guard units can submit a request through command channels to FORSCOM. Funds are available. Rotation dates are not optional, and units must accept the date assigned by FORSCOM. Participation by National Guard units would take a heavy load off active units now being overtasked with maneuver and OPFOR requirements.

Q. What method is used to obtain water for troops when the well-drilling rig isn't available?

A. The new well-drilling rig has the same maneuverability as a 5-ton truck. However, in rare situations when the well-drilling rig is not available, use the tactical water distribution system (TWDS).

Q. When probing a minefield using nonmetallic probes, does the prober carry his weapon with him?

A. When breaching a minefield with a nonmetallic probe, the soldier should strap the weapon securely on his back.

Q. What is the NSN for screw-type pickets?

A. Screw-type pickets (NSN 5660-01-072-2977) are not available at the depot. They have been replaced by U-shaped pickets which are easier to use, transport, and store. Also, U-shaped pickets are commercially used while screw-type pickets are not. The NSN for U-shaped pickets are 5660-00-270-1587 and 5660-00-270-1589.

Q. In a combat heavy engineer battalion, the alpha company direct-support shop is authorized a maintenance supply section. Is the mission of this section to support only the direct-support shop Class IX requirement or does it support the entire battalion of engineer Class IX repair parts?

A. The support battalion with Class IX repair parts is only for engineer equipment and power generation equipment. See MTOE 0511SHFC10.

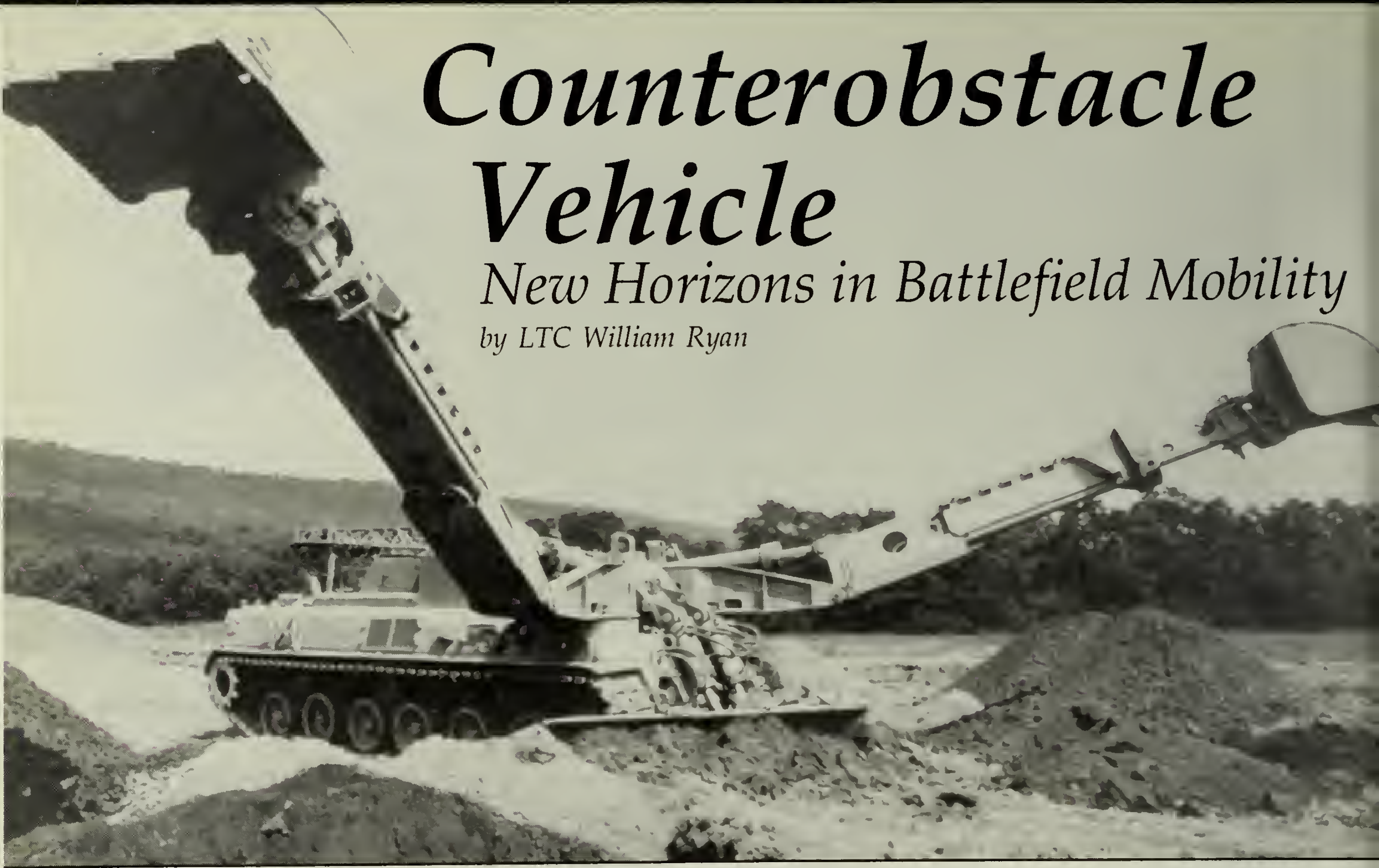
Do you have problems, questions, or comments relating to engineer doctrine, training, organization, and equipment? Call the US Army Engineer School's Hotline. You'll receive a reply within 3 to 15 days. The Hotline is not a receiving agency for formal requests.

The Hotline telephone number is (703) 664-3646; WATTS 800-336-3095, extension 3646; or AV 354-3646.

Counterobstacle Vehicle

New Horizons in Battlefield Mobility

by LTC William Ryan



Do combat engineers need the counterobstacle vehicle (COV)? I say *yes*. The need has been documented by AirLand Battle mission area analysis and Army 21 requirements.

Based upon extensive Soviet use of mines and obstacles in both offensive and defensive operations, combat engineers require a survivable system for countermine and counterobstacle tasks to support heavy forces.

Today's Army relies on a number of special-purpose combat engineer and construction equipment vehicles to marginally counter the mobility threat faced by the combined arms team.

But imagine one engineer vehicle that covers the spectrum of AirLand Battle mobility, countermobility and survivability missions. That's the COV.

Mobility Enhancement

The COV excels at minefield breaching. The best way to counter any minefield is to bypass it. However, restrictive terrain or manmade obstacles blocking the avenue can make this impossible. When forced to breach, engineers have two options–attack the fuze or the mine itself.

It used to be that most mines were pressure-rod or tilt-rod activated and vulnerable to pressure rollers. Today, mines are increasingly more sophisticated. They may have magnetic or multiple fuzes capable of defeating rollers and overpressure explosive systems. These mines must be removed or destroyed.

The Army currently uses a track-width mine plow on the M1 tank to remove mines from the tank's path. While effective, this doesn't provide a safe lane for following armor forces. The COV's full-vehicle-width mineplow corrects this deficiency.

Counterobstacle mobility tasks handled by the COV range from overcoming antitank ditches at the far end of minefields to clearing urban rubble in front of the combined arms team. For its counterobstacle role, the COV has two telescopic arms and a mine plow/dozer (configured as a bulldozer blade or V plow). In the bulldozer mode, the COV's earthmoving capacity equals the D8 tractor.

The two telescopic arms (each with a lifting capacity of 14,000 pounds and a 32-foot reach) accommodate a variety of attachments. Currently under evaluation are the:

- Lifting hook
- Hydraulic hammer and pavement breaker
- Grapple
- Auger
- 1.25-cubic-yard bucket

Quick change adapters allow engineers to change attachments in three to five minutes. All attachments can be used alone or in combination, depending upon the obstacle being breached.

Designed to replace the aging Combat Engineer Vehicle (CEV), the COV excels at battlefield mobility. But countermobility and survivability missions also come standard in the COV repertoire. During tests, the COV prepared hull defilade tank fighting positions in less than 10 minutes and an antitank ditch (5 meters wide, 120 meters long) in less than two hours.

Technology Integration

The COV prototype uses the basic hull and chassis design of the armored recovery vehicle. By modifying the upper hull so the crew sits in tandem, designers made room for telescopic arms on both sides. The standard four-man crew required for the CEV was reduced to three. An escape hatch, accessible to all the crew, was added in the floor.

A standard 908-horsepower, turbocharged, air-cooled diesel engine powers the COV. A standard Detroit Diesel Allison transmission provides

The COV's two telescopic arms (left) overcome obstacles and dig tank traps. A full vehicle-width mine plow/dozer blade (below) provides a safe lane for following armor forces.

the high torque required for heavy earthmoving. A remote suspension lockout adds chassis stability for plowing, dozing and digging. The lockout blocks are positioned by hydraulic cylinders controlled inside by the crew.

External hydraulic outlets on the chassis allow engineers to use a variety of hydraulic tools as the tactical situation permits. Tools carried on board include a wrench, hammer and saw. The rear compartment contains a slave receptacle for external electrical power, a remote telephone and a searchlight.

On board, an individual, microclimatic environmental control system provides NBC protection to improve crew efficiency while reducing stress under all environmental conditions.

The combination mine plow/bulldozer blade is driven by a 400-horsepower takeoff unit that provides up to 4,000 psi of operating pressure. The bulldozer blade is controlled manually by either the driver or center seat operator using a three-axis joystick to control the blade's roll, pitch, raise and lower functions.

The mine plow normally operates automatically through a computer integrated with three ultrasonic sensors suspended 10 feet in front of the plow.

When using the automatic depth control, the driver or operator simply selects the desired plowing depth depending on the types of mines encountered. The crew observes all plow movement through a set of passive fiber-optic viewers located on each side of the vehicle. The viewers allow perfect depth control if manual plowing becomes necessary.

The mine plow system has several configurations. In the full-width plow mode, two extensions (each 1 meter long) attach at each end to clear a mine-free lane more than 12 feet wide. With extensions removed, the V plow opens a path through battlefield debris and urban rubble.

The mine plow collapses to create a full-width dozer for earthmoving requirements. On-site, the conversion takes less than an hour.

Testing

To accelerate fielding, the COV has two development phases instead of the usual three. Production of fully operational technology demonstrators in the first phase made this possible. The second phase—production prototype testing and evaluation—will begin in March 1987.

Engineer design tests were just finished at the Belvoir Engineer Proving Ground, and troop demonstrations sponsored by the Engineer School are now underway at Fort Knox. Combat engineers there are evaluating crew-training requirements and the functional utility of the mineplow, bulldozer and telescopic arms. The US Marine Corps will evaluate the COV's force-integration requirements at Quantico, VA in June.

The COV is scheduled for initial production in fall 1989.

The Engineer School is the COV user proponent. The Army Materiel Command and TRADOC designated the Troop Support Command (TROSCOM) as the COV materiel developer and the Tank Automotive Command (TACOM) as the readiness activity. TROSCOM's COV project office is at the Combat Engineering Directorate of Belvoir R&D Center to allow close cooperation between TROSCOM developers and engineer users.

An aggressive preplanned product improvement program (P^{3}I) covers:

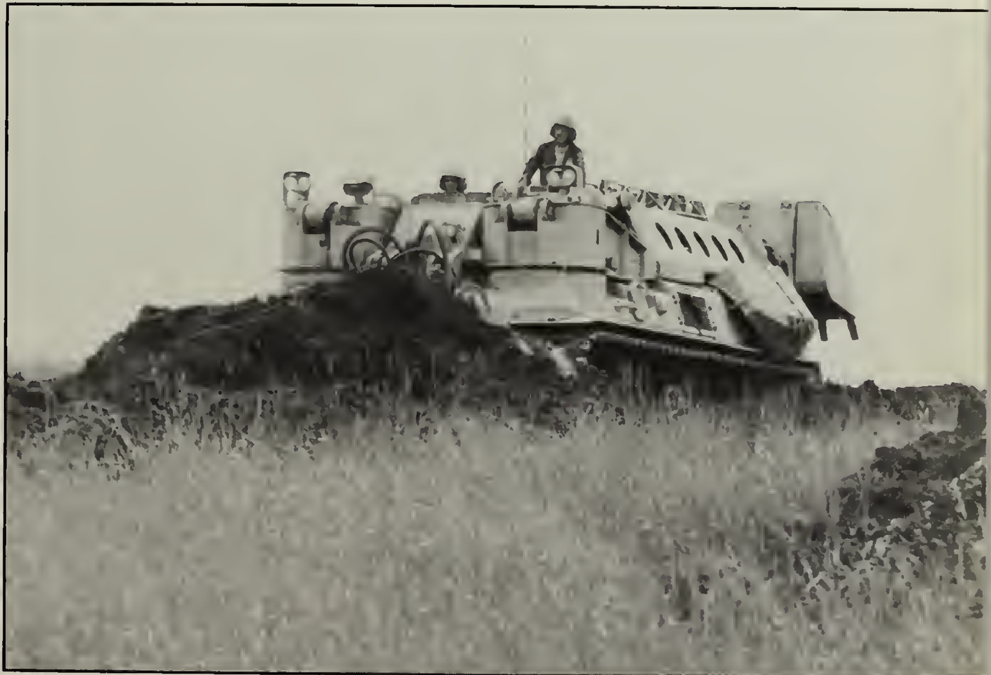
- Development of improved automatic depth control;
- Robotic applications for the telescopic arms to reduce crew workload and increase operational efficiency;
- An autonomous COV when the technology matures.

As a *force multiplier*, the COV greatly enhances the mobility, countermobility and survivability of the combined arms team. It gives combat engineers and their maneuver partners a decisive edge—both on the AirLand battlefield today and the Army 21 battlefield of the future.

LTC William Ryan is the COV project officer for the Belvoir R&D Center. He holds a research and development specialty code 51 and is in the materiel acquisition manager program. He has attended the Command and General Staff College at Fort Leavenworth and the Program Managers Course at the Defense Systems Management College.

His infantry assignments include: platoon leader, 82nd Airborne Division; company commander, 173d Airborne Brigade (Vietnam); battalion S-3; and XO in the 1st Infantry Division Forward in Germany. He has also served as a ranger school instructor and a test and evaluation officer.

He has an undergraduate degree from Henderson State University in biology and an advanced degree in management from Central Michigan University.



Combat Heavy Deployment Checklist

by CPT Samuel W. Burkett

It's been a hectic week for the combat heavy engineer battalion. As commander of Company B, you are pushing to complete road construction ahead of winter rains. You are ready for the weekend when the message comes down late Friday — the battalion commander has called a meeting for 1600. It's not the first late meeting... probably more problems with trash at the motor pool.

You arrive hoping to finish quickly. But the battalion commander's announcement catches everyone by surprise. You deploy to Honduras in two weeks. Duration is unknown, but the mission is construction—roads, airfields, and temporary base camps.

Friday just became a new Monday, but you are too busy to worry about the weekend you'll miss.

With increasing frequency, Army engineers are deploying on short notice to foreign countries to build roads, airfields and base camps. Recently much of the action has been in Central America, but company commanders must be prepared for a late Friday call that could send them anywhere in the world.

When units arrive, they must be able to operate, maintain security, and complete a variety of engineer missions for extended periods of time. If important equipment or material is left behind, it may be months before the deployed unit sees it again.

This checklist offers guidelines for company commanders who must make quick decisions about what to take and what to leave behind. It is by no means complete, but provides the combat heavy battalion a basis for planning on a moment's notice. Deploying units should add and delete items depending upon the mission, shipping space, known security threat, and the commanders' preferences.

S-1. Personnel.

Material and equipment to take.

1. Typewriters and field files.
2. A field 201 file on each soldier.
3. Publications.
4. Each soldier should bring (in addition to TA-50 and uniforms):
   a. Running gear.
   b. Extra shaving and shower supplies.
   c. Stationery and stamps.
   d. Books and magazines.
   e. Other items depending on space, mission and geographical area.

Actions to accomplish before deployment.

1. Ensure each soldier has prepared a will and assigned power of attorney.
2. Secure and store privately owned vehicles (POVs).
3. Arrange storage and security of soldiers' household goods and personal items.
4. Brief dependents on:
   a. Mission (if possible).
   b. Where help can be found (Army Emergency Relief, Red Cross, chaplain).
   c. How to contact soldiers in an emergency.
   d. Information necessary for each family to conduct daily activities in spouse's absence.

Questions to ask.

1. What will mail procedures be?
2. What will the mailing address be?
3. What financial support will be provided?
4. Can personal and government checks be cashed?
5. What is the local currency exchange rate?
6. What channels will handle all types of personnel actions?
7. Will replacements be provided after the unit deploys?
8. How will replacements be processed?
9. How will emergency leave be processed?
10. How will soldiers be returned to their home station?

S-2. Intelligence.

Material and equipment to take.

1. Maps.
2. Publications.
3. Overlay material.
4. Camera.

Actions to accomplish before deployment.

1. Request and distribute maps.
2. Brief commanders and staff on weather, enemy situation and local population.

Questions to ask.

1. Where is the nearest U.S. Embassy?
2. What is the condition and capability of the road network?
3. Are there any local sources of construction material?
4. What are the dangerous animals and insects in the area?
5. Where are local water sources located?
6. Who are the host nation points of contact and coordination?
7. What is the overall situation including:
   a. Any terrorist threat?
   b. Recommended level of security?
   c. Friendly factions?
   d. Anti-U.S. groups?
   e. Attitude of host nation to U.S.?

8. What is the weather including:
    - a. Average temperatures?
    - b. Rainfall?
    - c. Stormy/rainy season?
9. What is the terrain like including:
    - a. Vegetation?
    - b. Trafficability?
    - c. Major features such as rivers and mountains?
    - d. Types of terrain (mountainous, flat, rolling, swamp)?

S-3. Operations and Training.

Material and equipment to take.

1. Applicable publications.
2. Adequate drafting and surveying supplies.

Actions to accomplish before deployment.

1. Conduct special classes on:
    - a. Radio procedures.
    - b. Medical hygiene and disease prevention.
    - c. Climate (cold/hot weather).
    - d. Perimeter security.
2. Complete a thorough inspection of TA-50.
3. Inspect and fire all weapons.
4. Give special training to complete a specific mission.
5. Find out as much about the mission as possible.
6. Identify all soldiers that speak the language of the country.

Questions to ask.

1. What relationship will our unit have with other units (attached, direct support, general support, OPLAN)?
2. What headquarters is responsible for giving missions to engineers?
3. What types of reports will be required?
4. Are there any convoy restrictions or special procedures?
5. What is the expected mode of deployment (air, land, sea)?
6. What are the dates of deployment?

S-4. Supply.

Material and equipment to take.

1. Trash cans.
2. Cots.
3. Tables and chairs.
4. Additional tents.
5. Water cans (potable).
6. Water purification supplies.
7. Extra tools and repair parts (based on mission).
8. Construction materials (for initial construction and based on mission).
9. Sandbags.
10. Concertina.
11. Barbed wire.
12. Pickets.
13. Basic load (ammo).
14. Barber kit.
15. Toilet paper.
16. Laundry soap.
17. Athletic gear.
18. Cleaning supplies.
19. Medical supplies.
20. Pens and paper.

Actions to accomplish before deployment.

1. Complete an accurate inventory.
2. Issue each soldier supplemental TA-50 based on geographical area.

Questions to ask.

1. Are express containers and military owned containers (CONEXs and MILVANs) available for storage, shipping and security?
2. Can the priority of supply requests be upgraded?
3. What headquarters will process supply requests after deployment?
4. Who will supply fuel?
5. How will it be stored?
6. What is the location of the troop issue subsistence activity (TISA)?
7. What ration cycle will be used?
8. Who will supply laundry/shower support?
9. Who will supply water purification support?
10. Is an impress fund available for limited local purchase?

S-4. Maintenance.

Material and equipment to take.

1. Prescribed load list and authorized stockage list (PLL/ASL).
2. Extra tires.
3. Extra batteries.
4. All tools and repair equipment.
5. As many additional parts as the commander will authorize with the shipping and storage available.

Actions to accomplish before deployment.

1. Ensure all tools are on-hand and in good condition.
2. Replenish bench stock for organizational shop vans.
3. Have preventive medicine personnel inspect mess equipment and water buffalo.
4. Secure on-vehicle material in a CONEX. (It may be lost or stolen if left on the vehicle.)
5. Complete inspection and repair of all vehicles and equipment.

Questions to ask.

1. Can the priority of parts requests be upgraded?
2. Who will provide higher level support maintenance?
3. How will it be provided?
4. Are there any commercial construction equipment dealers in the develópment area (local sources for repair parts)?

CPT Samuel W. Burkett is working on the Carswell AFB Hospital renovation and expansion project with the Fort Worth District. He graduated from the U.S. Military Academy and completed EOBC and EOAC. He served as a platoon leader, S-1, S-2, and company XO, with the 46th Engineer Battalion (CBT)(HVY), Fort Rucker, AL. CPT Burkett deployed with the 46th on REFORGER in 1982 and to Honduras for AHUAS TARA II from September 1983 to February 1984.

Soviet Engineers in Combat

The Objective is Rapid Advance

by CPT Charles R. Boyer

The guiding Soviet principle of land warfare is violent, sustained, deep offensive action. Mechanized and armored formations, supported by aviation and artillery, are to seize the initiative at the outset, penetrate enemy defenses, and drive deeply into the rear.

To accomplish this, highly mobile, armor heavy Soviet forces will attack in successive echelons hoping to overwhelm enemy defenses—an operation that relies heavily on engineers.

The Offense

The Soviet engineers' primary mission is to clear and maintain routes to sustain rapid advance. They remove mines and obstacles, cross water obstacles, protect the flank, and aid against counterattack.

Engineers are included in all reconnaissance elements of tank and motorized rifle units. They report the condition of advance routes, providing the main body with information on assembly areas, detours around obstacles, and warnings of minefields and craters. The engineer reconnaissance patrol is equipped with portable mine detectors and route-marking flags.

The Soviets stress that water obstacles must be crossed from the march to preclude major halts in the offense. Their doctrine dictates crossings at multiple points along a broad front to overwhelm the enemy. Smoke is used extensively to mask assault crossings during daylight.

Engineers reconnoiter water obstacles to find fording sites and suitable entry and exit points for combat vehicles. Detailed terrain analysis is required for bridge and ferry sites. Reconnaissance of tank-fording sites requires divers and a tracked amphibian with river-reconnaissance devices.

Engineer river-crossing capability is found in the regimental engineer company organic to motorized rifle and tank regiments; the division engineer battalion; and special engineer battalions, regiments and brigades at army and *front* level.

Movement Support Detachments

During marches, movement support detachments (MSDs) travel ahead of the main body, clearing obstacles reported by reconnaissance teams. They fill craters, clear mines and prepare bypasses around major obstacles.

The MSDs are task organized from divisional or regimental engineer assets based on mission and availability. They can be from platoon to company strength and are equipped with route and mine clearing vehicles and equipment. An MSD's bridging capability is normally limited to equipment required for its own movement.

A division engineer battalion can form two to three MSDs. They are employed on main routes and travel under the protection of an advance guard or forward security element whenever possible.

On other routes, the leading regiments provide MSDs from their own resources. A typical MSD at this level might consist of an engineer platoon with one or two dozers and up to three tanks fitted with dozer blades. These MSDs are protected by up to a platoon of infantry or tanks and are often accompanied by chemical reconnaissance personnel.

Breaching Minefields

Normally during an assault or rapid advance, the Soviets breach minefields using mine plows and rollers fitted to the lead tanks. Although engineers reconnoiter the minefield, the initial breaching is not primarily an engineer task.

Engineers assist in fitting the plows and rollers which are commonly used for minefield reconnaissance. These are usually employed on the scale of one per platoon of three to four tanks. The Soviets estimate clearing speeds of about 10 kilometers per hour (kmph) for plow-fitted tanks, and up to 22 kmph for roller-fitted tanks.

Combat vehicles that aren't on tank chassis must wait until the full width of the lane is cleared. This is often done by tanks with plows or rollers that tow line charges across the minefield, then detonate the charges.

The Soviets also use a mine-clearing device mounted on the BTR-50PK APC (two to each divisional engineer battalion). An explosive line charge is fired across the minefield and detonated. This clears a lane six- to eight-meters wide.

The BTR-50PK is particularly useful during assault river crossings when there are minefields on the far bank, and amphibious APCs may have to operate initially without tank support in the bridgehead. An average of four to six lanes can be expected. Of these, at least two will be developed into permanent lanes for artillery and logistics vehicles.

Mobile Obstacle Detachments

Special teams called mobile obstacle detachments (MODs) are formed from regimental and divisional engineer assets. Their mission is to rapidly mine the most likely avenues of enemy attack or counterattack. The MODs travel on the flanks of a march column or formation where they can deploy rapidly. They are normally near the antitank reserve.

Minefields are most rapidly laid using armored, tracked mine layers (three to each divisional engineer battalion). Hand emplacement and towed mine layers are also used.

Both the tracked mine layers and mine-laying trailers dispense mines at predetermined spacings of 4.0 or 5.5 meters. On suitable ground, a division's three armored, tracked mine layers can surface lay a three-row, 1,000-meter-long minefield in a half hour. In the same time, a regimental MOD's three mine-laying trailers could lay about 500 meters of minefield.

The Defense

The Soviets consider the offense the only means to decisive victory. Defense is a temporary posture leading to resumption of the offensive. The engineers implement obstacle plans (particularly antitank obstacles) to block enemy penetrations. A MOD may join antitank reserves to counter enemy tank threats. They also repair existing routes and create new routes to support maneuver forces. They respond to enemy nuclear strikes with fire fighting, structure repair and debris removal.

Mechanized earthmoving equipment is used in survivability missions to dig trenches and build revetments or shelters in areas not exposed to direct enemy observation or fire. Because self-entrenching blades are standard on many tracked vehicles (tanks, self-propelled artillery), a Soviet division could probably dig in all of its combat vehicles within three hours.

To some extent, all troops construct fortifications, shelters and vehicle revetments. However, the engineers construct the more complex fortifications.

Countermobility

During countermobility operations, engineer troops normally construct barrier systems which are coordinated with the overall system of fire. The first priority is antitank obstacles. Mechanized diggers can dig up to 400 meters of antitank ditch per hour depending on the dimensions of the ditch, soil conditions and terrain.

Defensive minefields are laid in much the same manner as flank-protection minefields. The quality and specific structure of the minefield depends upon time and terrain. However, the doctrinal guidance describes three rows of mines per belt, up to 100 meters between rows, and three belts per field, with the field covered by fire whenever possible. Additional countermobility capabilities include road cratering, wire barriers and abatis.

Conclusion

Engineers play a vital role in maintaining maneuver mobility in land warfare. The Soviet army's emphasis on rapid advance directly reflects their desire to fight and win. Their engineers are well trained, well equipped and ready.

CPT Charles R. Boyer, an intelligence officer, is chief of the Threat Branch, Directorate of Combat Developments, USAES. He has served in intelligence assignments in both CONUS and Germany and is a graduate of Penn State University.

The Army Occupational Surveys for MOS 12B and MOS 12C will be distributed to selected engineer units in May. These surveys will gather task performance and training information from a large sampling of soldiers, E-1 through E-7, and use the data to improve combat engineer training.

Please answer each item of the survey carefully, since this is a unique opportunity for *you* to influence training.

One Year After The Green Ribbon Panel

USACE

Support Of Army Installations

by Col Stephen F. Rutz and Victoria Mc Allister

> *"The activities managed by the installation commander's Director of Engineering and Housing (DEH) are on the critical path of nearly everything that happens on Army installations. Readiness, recruitment, retention, force structure, modernization, training, mobilization, the Army Family, quality of life — all these important elements of today's Army depend upon effective, efficient facilities engineering and housing support."*
>
> *—Green Ribbon Panel Report*
> *on U.S. Army Corps of Engineers (USACE)*
> *Support to Army Installation Commanders, March 1985*

In October 1984, the Chief of Engineers, LTG E.R. Heiberg III, appointed a Green Ribbon Panel of senior officers and civilians to evaluate USACE support to Army installation commanders and recommend areas for improvement.

The panel found that *"the job of providing quality, timely support is a tough one . . . one that requires excellence and teamwork on the part of both the DEH and supporting district engineer."*

Installation support is a complex, $5-billion-a-year business, aggravated by numerous regulatory and statutory restrictions. Seven areas were identified where improvement would significantly enhance support to soldiers and their families:

- USACE installation support priority
- Responsiveness and efficiency
- Policies and procedures
- The cost of doing business
- Procurement support and commercial activities
- Education, training and career development
- The scope of USACE support

What changes have been made in the year since the report? While there have been few easy solutions, there has been significant progress. Here is a status report on the major initiatives underway.

USACE Installation Support Priority

At the heart of the Green Ribbon study was the panel's finding that despite the importance of USACE's role in assisting the DEH with installation support, the mission was not adequately described in Army regulations. This left Corps districts to take a makeshift approach to installation support in comparison to their traditional military construction and civil works responsibilities. Successful installation support generally reflected the personal efforts of the staff involved rather than a clear mission definition. However, even the best DEHs and districts had difficulty communicating because the support role was poorly defined.

Echoes of this problem are present in many of the issues identified by the panel. The report concluded that *"USACE must demonstrate dedicated support and flexibility in response to DEH mission needs in equal measure to its more traditional military construction (MCA) and civil works missions. The top priority of the installation support mission must be apparent to all."*

As a result, major changes are being made to key Corps policies and Army regulations.

In February 1986, the Chief of Engineers issued new policy that makes installation support a factor in the job descriptions, performance standards and officer efficiency reports of many USACE personnel. The goal is to ensure the same attention is given to installation support that is given to other critical missions. The USACE support role to DEHs will also be described in updates to DA Pamphlets 420-6 and 420-8 and AR 420-10.

The awards program to publicize superior district support performance is in place. The first winner is being presented the award at the USACE Commanders' Conference in May.

The issue of which district should provide installation support is being evaluated for some installations. In many cases, the Corps' *direct service support* military construction district for a particular installation is distant while another civil works district has offices virtually across the street. DEHs and installation commanders frequently feel they would receive more responsive service from the closer district.

The Chief of Engineers has directed that the *direct support* responsibility be shifted to the closest district where it makes sense within Corps divisions and can be done without increasing division manpower. Manpower availability is one of the sensitive issues that will govern the extent to which changes can be made in the years ahead. The Corps is also considering possibilities for interdivisional workload shifts. The emphasis will be on making efficient use of the Corps' *brokerage system* to assign work from geographically distant *direct service districts* to *general support district* offices.

USACE must demonstrate dedicated support and flexibility in response to the DEH in equal measure to more traditional military construction and civil works missions.

Responsiveness and Efficiency

The Green Ribbon Panel found that design, construction and operations procedures that govern district services for repair and maintenance projects must be streamlined and simplified.

The support a DEH needs to carry out a maintenance and repair project paid for by installation (OMA) funds differs significantly from the support required for major military construction (MCA) projects funded by Congress. Management control procedures do not adequately describe how the installation support relationship is supposed to work, so districts have improvised based upon conservative MCA models.

To tackle this problem, USACE is implementing a simplified set of model contract provisions for maintenance and repair contracts to be awarded this summer. Congress is also considering simplified competitive acquisition techniques that would streamline contracting procedures for projects in the $25,000 to $5 million range.

Job Order Contracting—a quick way to contract small repair jobs or *new work* projects—is being tested at five sites: Fort Ord, Fort Sill, Fort Bragg, Fort Monroe and Aberdeen Proving Ground.

An effort is also being made to improve communication and accountability on architect-engineer contracts that districts administer for the DEH. A test is under way to send architect-engineer design teams to job sites during construction to discuss problems with customers. Results are due this summer. DEHs are also being educated on options to extend one-year contracts with reliable architect-engineer firms for a second year to capitalize on experience.

Policies and Procedures

The Green Ribbon Panel recognized that responsiveness is largely an attitude—a dedication to communication and teamwork on the part of the DEH, the district engineer and their staffs. Attitudes cannot be regulated, but they can be fostered by policies that encourage initiative and make the DEH/district engineer team more effective. The panel recommended several policies that are now being implemented to enhance smooth operations:

- Policy is being revised to improve flexibility in the use of K and L account money to modernize aged facilities that need major renovation or repair. The panel found the work classification criteria so restrictive that newly renovated facilities frequently fell short of modern standards in essential areas such as utilities and electrical systems, user requirements and space utilization. The new policy is being sent to major commands for staffing.
- Provisions are being made that will provide a *warranty* for qualifying maintenance and repair projects accomplished by USACE districts—similar to guarantees for MCA projects. The USACE is establishing a procedure to correct problems due to design error, construction deficiency or contractor warranty disputes that cannot be resolved by the district, the DEH and the major command. This means an installation can correct facility problems without waiting until negotiations between the district and the contractor (or ligitation) are complete. Details on the new procedure will be published this year.
- Several Army agencies such as AAFES, NAF and TSA have their own construction funds. The Green Ribbon Panel recommended that the Corps ensure that these agencies use the normal DEH master planning process to obtain new facilities. A command letter will be sent to these agencies that directs compliance with the new master planning regulation AR 210-20 and the programming procedures in AR 415-19.

The Cost of Doing Business

The panel found DEHs believe that district services for professional engineering and contract management are more expensive than in-house costs. DEHs and district engineers have different accounting methods which distort a comparison of costs for similar services. For example, the DEH in-house cost for a project does not include overhead which is carried in the overall installation account. Districts, on the other hand, must add overhead to project costs.

To clarify the cost breakdowns applied to installation support services, Engineer Pamphlet 37-1-4, *Cost of Doing Business*, is being published for distribution to major commands and divisions this fiscal year. It will help DEHs understand how districts charge for services provided as part of a reimbursable project.

A new 7.5% supervision and administration rate for maintenance and repair projects established in April 1985 is being evaluated this year to determine if it adequately covers construction management costs. If not, the rate will be adjusted.

The Green Ribbon Panel also found that procedures used to transfer funds between DEHs and districts for operations and maintenance (OMA-funded) projects are too complex. Federal statutes preclude much simplification. However, Europe Division has been using direct fund cite procedures for contracts. The Installations Finance and Accounting Office is cited for progress payments. These procedures have always been authorized. Other districts may consider this if it simplifies local administration

Procurement Support and Commercial Activities

One of the most difficult issues explored by the panel involves contract authority. The Commercial Activities Program (A-76) and DEH manpower constraints have increased the DEH's reliance on contracting without giving him contract administration authority. The Green Ribbon Panel recognized the DEH needs authority to start, stop and change a contractor's operation, and to alter the scope and dollar amount of the contract. Without it, he has difficulty responding to emergencies and unforeseen developments.

The Corps is asking to decentralize contracting control to a degree that will give the DEH authority with teeth at a time when the Army is trying to streamline, tighten and consolidate the procurement business. The new standard installation organization is consolidating contract management under a contracting officer who will report directly to the installation's chief of staff. Until the new system has been tested with the DEH's full, professional support, it will be difficult to justify further decentralization.

The Facilities Engineering Support Agency (FESA) has improved DEH training on the commercial activities program by preparing model performance work statements and sharing *lessons learned* at conferences and site visits.

Education, Training and Career Development

Professional development of the DEH work force and cross-training with district engineer staffs were major concerns of the Green Ribbon Panel. The panel found that while DEH workloads have increased and become more complicated, the size and average grade of the DEH work force has declined. The panel said the disparity in grades between the DEH and district engineer professional staffs is a deep-rooted problem that hinders successful recruitment and retention of qualified DEH personnel. Several initiatives to tackle these problems are underway.

A critical first step is to see that installation commanders and their key personnel better understand the complexity of DEH management. The *Installation Commander's Guide* has been revised to better explain and publicize the objectives, capabilities and procedures that govern installation support. Draft copies are now available. The new version will be published as DA Pam 420-XX in FY 86.

> ***Responsiveness is largely an attitude — a dedication to communication and teamwork. Attitudes cannot be regulated but they can be fostered by policies that encourage initiative.***

The disparity in job classification—the perception that civilian grade structure for key DEH management positions is lower than for their district counterparts—is being reviewed by the Army's Deputy Chief of Staff, Personnel. A review of key DEH positions at several installations will be completed this summer to determine whether changes based on managerial responsibility and work complexity are justified.

The engineer intern program is also being revitalized to add cross-training between district and DEH personnel. DEH interns will spend four weeks at the supporting district. District interns will spend two weeks with the DEH.

The entire issue of DEH training is being reviewed by a task force. Currently, training responsibility is fragmented among FESA, USAES, the USACE Training Management Division (Huntsville), ALMC, AMETA, 7th Army Training Center and others. In the meantime, the number of training spaces allotted to DEH personnel at Huntsville has been raised from 12% to 20% of the total. A pilot test of television satellite transmissions to remote classrooms to expand training opportunities is planned.

Finally, the Green Ribbon Panel recommended that career progression patterns for engineer officers be modified to give more junior officers DEH experience. The Corps needs a bigger base of experienced, knowledgeable senior officers for critical DEH assignments.

The Scope of USACE Support

The last area of the panel's report discussed the need to improve support for other types of DEH activities such as automated master planning, preparation of construction project approval documents (DD Form 1391), and support to upgrade Army Reserve Center facilities. A separate Green Ribbon Panel report on USACE support to the reserve component was recently submitted to the Chief of Engineers.

The entire issue of improved support of installation master planning and construction programming is being studied based upon the results of the *Engineer Inspector General Report on the Military Construction Design Release Process, 26 July 1985.*

Efforts are also underway to promote the research and development services and the technology transfer information available through the Corps laboratories. *One Stop* support calls to the labs have steadily increased. The Engineer Circular 70-1-13, *Research and Development*

One-Stop Service, lists more than 50 areas in which help is available along with phone numbers and points for contact.

Conclusions

Substantial improvements to Corps support of the DEH and installation commander have been made in the year since the Green Ribbon Panel report. We will be better able to measure the effects of these changes in the year ahead.

> ***. . . the Fort Sill DEH and the Tulsa District Engineer found they had authority to resolve 80-85% of the issues between them without special exemptions to regulations and policy.***

However, the most fundamental observation of the Green Ribbon Panel goes beyond changes to regulations, policy and programs. Support is an attitude—a spirit of cooperation and teamwork. Success will always depend largely upon making the engineer family a family that truly cares.

The experience of the Fort Sill DEH and the Tulsa District Engineer working together in the Model Installation Program bears this out. Although the program allows ample opportunity to experiment with changes to regulation and policy, they found they were able to resolve 80-85% of the issues between them without special exemptions.

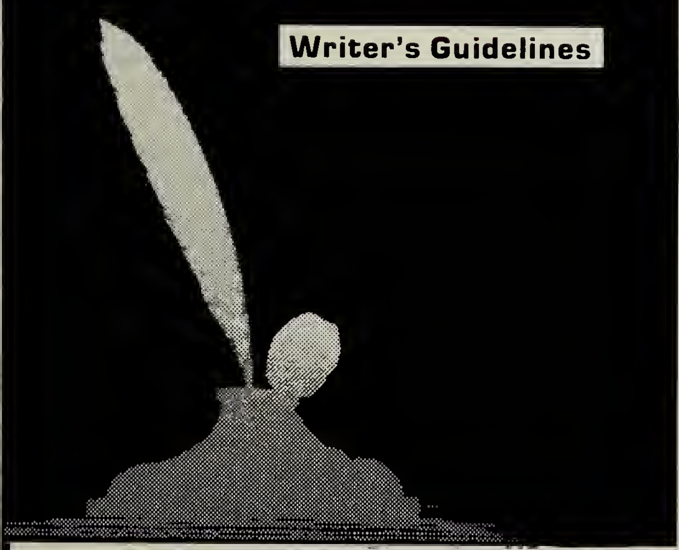
Many of the solutions being implemented in response to the Green Ribbon Panel are also the result of programs already worked out by a DEH and a district that could be shared as models for the rest of the Corps. The key to our progress is the communication and spirit of cooperation that initiatives like the Model Installation Program and Green Ribbon Panel stimulate.

The Chief of Engineers has established *Leaders in Customer Care* as the theme for the engineer family. The Green Ribbon Panel initiatives are a good beginning. Your comments and observations are invited.

COL Stephen F. Rutz is chief of the Installation Planning Division for the Assistant Chief of Engineers (ACE). He served as the deputy district engineer for the New Orleans District from 1983-85. He was chief of the Facility Programs Branch for the U.S. Army, Europe (USAREUR) Deputy Chief of Staff, Engineer (DCSENGR) in 1982-83. He also analyzed the DEH organization and mission workload in Europe in 1981 as special assistant to the USAREUR DCSENGR.

Victoria McAllister is features editor for ENGINEER. She was the engineer information officer and editor of THE SCOOP for the USAREUR DCSENGR and Installation Support Activity, Europe, from 1980-85.

Writer's Guidelines



Do you have any articles, photographs, or artwork to submit to ENGINEER? Here are some tips.

TOPIC: We focus on combat engineering; however, any articles of interest to engineers are welcome. Write in active voice and be as concise as possible. Please give your article a title, too.

LENGTH: Let your subject dictate length; generally, articles should be two to six pages, double spaced.

PHOTOGRAPHS AND ARTWORK: Besides photographs and artwork which supplement articles, photographers and artists should submit any work that may be of interest to engineers. Your photos should be 5 x 7 black and white, glossy. (We can also use good quality color slides.) Please include a caption and photo credit. Drawings should be legible, but do not have to be camera ready.

DEPARTMENTS: We are always looking for items for our departments:

- **Letters to the Editor.**
- **Engineer Ingenuity.**
- **Engineer People.**
- **News and Notes.**
- **Personal Viewpoint.**

ENGINEER PROBLEM: Please submit your challenging—but not too hard—Engineer Problems. Problems should be referenced to a manual, but must be original. They should be checked for accuracy and should strengthen combat engineer skills as well.

COVER LETTER: When submitting material to ENGINEER, enclose a cover letter with your name, address, and phone number. Also, please include biographical information such as military and civilian education and past and present assignments.

If you have any questions, please call us.

(703) 664-3082, AV 354.

The Cross-FLOT Raid

Engineers in the Deep Battle

by LTC Larry Izzo

**SP4 Donald Wayne and SP4 Richard Whit
307th Engineer Battalion, storm the John
Kerr Dam control room.**

Photo by 1LT Peter F. Tay

One of our Army's goals is to train as we intend to fight. AirLand Battle doctrine tells us how we think we are going to fight. It postulates a battlefield on which disruption of enemy activities in depth will be a routine feature of both offensive and defensive operations.

Unfortunately, little attention has been devoted to the use of engineer strike operations to support the main battle. In an effort to revitalize this capability, the 307th Engineer Battalion, 82nd Airborne, stages monthly night raids to destroy targets behind enemy lines. They provide tough, realistic professional development opportunities for platoon leaders and exciting training for soldiers. These raids capture the essence of the four tenets of AirLand Battle doctrine:

- ***Initiative***—setting or changing the terms of the battle.
- ***Agility***—reading the battlefield and acting faster than the enemy.
- ***Synchronization***—arranging combat activities in time and space to maximize combat power.
- ***Depth***—extension of the battlefield; planning for rear and deep operations that support the close battle.

Training Scenarios

The battalion has developed several Cross-FLOT scenarios including some in cooperation with the Corps of Engineer District in Wilmington, NC, and civilian industries: Targets include:

- The Philpott and John H. Kerr Dams—raid the power station and deny electrical generating capability to the enemy without destroying the dam.
- The AMOCO oil storage facility at Greensboro—attack the enemy POL distribution point without destroying the fuel that friendly forces plan to capture at a later date.
- Bridges and communications bunkers at Fort A.P. Hill and Camp LeJeune—demolish a native timber bridge or other structures constructed for the exercise.

Each month the battalion rotates a new platoon through one of the scenarios, giving the platoon leader a chance to plan and lead an air assault engineer raid. Time fuzes and blasting caps add realism to simulated demolitions at civilian facilities. Actual demolitions are used at Fort A.P. Hill and Camp LeJeune. An aggressor detail from the battalion is at the target to provide realism, control and cleanup assistance.

Combined Arms Team

Although the engineer battalion plans the exercise, the training is a division combined arms operation. The 33-man patrol is a representative slice of the division's combat power. Three UH-60 Blackhawk helicopters from the aviation battlion provide transportation for the patrol which typically consists of:

- An air defense artillery stinger team.
- A tactical satellite (TACSAT) communications radio team from the signal battalion to communicate with home station.
- An infantry squad for security.
- Engineer elements to carry out the demolitions missions.

Pathfinders and teams from the division reconnaissance platoon are inserted near the objective a few hours to a day early. Pathfinders mark the landing zone (LZ) for the night landing and orient the patrol leader towards the objective. The reconnaissance team maneuvers close to the objective and keeps it under surveillance. They send intelligence back to home station for the patrol leader, both before and after he reaches the LZ. When available, Cobra helicopters provide fire support.

Planning Considerations

As simple as the Cross-FLOT concept sounds, the raid is challenging and complicated. As with all air assault operations, the engineer raid has four basic steps:

- The ground tactical phase.
- The landing phase.
- The enroute phase.
- The loading phase.

Planning considerations are shown in Figure 1.[1] The patrol leader also plans the engineer portion of the mission. The Cross-FLOT aspect adds to the difficulty:

- How can the patrol survive getting through the FLOT?
- What fire support can it rely on?
- What are the escape and evasion plans if aircraft are lost across the FLOT?[2]

The Mission

The exercise begins when the platoon leader and his company commander receive the battalion operations order.

Although Cross-FLOT is primarily a platoon leader's training exercise, the company commander plays an essential role. He selects the platoon and times the operation so it is compatible with the company training plan. When the operations order arrives, he coaches the platoon leader through the planning phase. During the exercise, he may accompany the patrol as an observer or evaluator. Thorough evaluation is essential to get maximum benefit from the exercise.

The decision on how much time the patrol leader will have to plan the operation is a compromise between two competing factors. On the one hand, the platoon needs time to plan and rehearse; on the other, it must be realistic in terms of what the unit would experience in battle.

The battalion found that 24 to 36 hours allows time to assemble the team, plan, rehearse, hold the air mission conference, backbrief, and insert the reconnaissance elements. It also places realistic pressure on the patrol leader and patrol. Of course, the battalion staff must coordinate use of the target facility and participation by division assets in advance.

The mission consists of:

- Pickup at a friendly pickup zone (PZ).
- Night aerial navigation to a LZ that is 20 to 100 miles off post.
- Linkup with the pathfinders on the LZ.
- Navigation to the objective.
- Reconnaissance and the assault.
- Demolition of the target.
- Movement to a nearby PZ for extraction.

The helicopters either laager in the vicinity or refuel at a nearby airport. A tactical arming and refueling point (FARP) is sometimes used. While this adds realism, it demands a great deal more planning, coordination and aviation assets.

Lessons Learned

Cross-FLOT proves Clausewitz was correct: "Everything in war is very simple, but the simplest thing is difficult."[3]

In every raid, Clauswitz's concept of *friction*—those countless, unforeseen, minor incidents which make the real battlefield so different from war on paper—is clearly demonstrated. Sure enough, patrol leaders are continually surprised by unexpected difficulties associated with air assault operations attempted at night in unfamiliar terrain.

Important lessons learned during Cross-FLOT raids include:

- Despite the use of the UH-60's Doppler system and night vision goggles, pilots frequently experienced difficulty navigating at night when traveling long distances over unknown terrain. Carefully selected routes are essential to find the correct LZ.
- Maintaining communications between the patrol on the ground and the UH-60's is difficult but imperative to correctly time the extraction.
- Detailed rehearsals are mandatory for a night operation. Without them, coordinated patrol action is impossible.
- Land navigation at night in enemy territory always takes longer than planned.
- Intelligence preparation is critical. The patrol needs reliable information regarding enemy strength at the target, nearby relief forces, and the locations of air defense enroute to and at the objective.
- Use of pathfinders and reconnaissance teams is beneficial, but they must be carefully briefed to avoid compromising the patrol early.
- Planning must be meticulous and comprehensive. It must cover aspects such as:
  - — actions upon encountering enemy or civilian personnel enroute to the objective;

307th Engineers Blow Up Dam

by 1LT Peter F. Taylor

Company A of the 307th Engineer Battalion blew-up the John H. Kerr Dam on the North Carolina and Virginia border last fall during a Cross-Forward Line of Own Troops (Cross-FLOT) engineer raid.

Cross-FLOT raids train and test engineers for operations behind enemy lines.

The dam raid began when airborne engineers were inserted on a landing zone (LZ) several miles from their target by Blackhawk helicopters from the 1st Battalion, 17th Air Cavalry. From the LZ they maneuvered with reconnaissance and pathfinder support to the dam. Friendly partisans left an access door open into the guarded power station.

The engineers entered the facility and moved undetected to their objective—the dam's control room. Using simulated demolitions, they rigged and blew up the facility. They were picked up at a prearranged time by Blackhawk helicopters at a pick-up zone adjacent to the dam.

1LT Peter F. Taylor is the S-2 for the 307th Engineer Battalion.

— what to do with prisoners;
— extraction of wounded;
— fire support crossing the FLOT and at the objective.

- A thorough air mission conference is critical to success. The patrol leader should not view the helicopters as taxis, but as an integral part of the patrol. He should rely heavily on the air mission commander's expertise.

Conclusion

The 307th Engineer Battalion's Cross-FLOT raids are excellent professional development exercises for the platoon leaders who lead the patrols and great training for patrol soldiers. Combat engineers will be called upon to execute such missions as part of a total combined arms team on the AirLand battlefield. The projection of this combat power deep across the FLOT on a well-timed operation in support of the main battle ties together all four tenets of AirLand Battle doctrine.

LTC Larry Izzo is in the U.S. Army War College Advanced Operational Studies Fellowship Program associated with the School of Advanced Military Studies at Fort Leavenworth, KS. He previously commanded the 307th Engineer Battalion at Fort Bragg, NC. LTC Izzo, a 1967 USMA graduate, has a master's degree in Nuclear Engineering from MIT and an MBA from Long Island University. He is a registered professional engineer in Virginia.

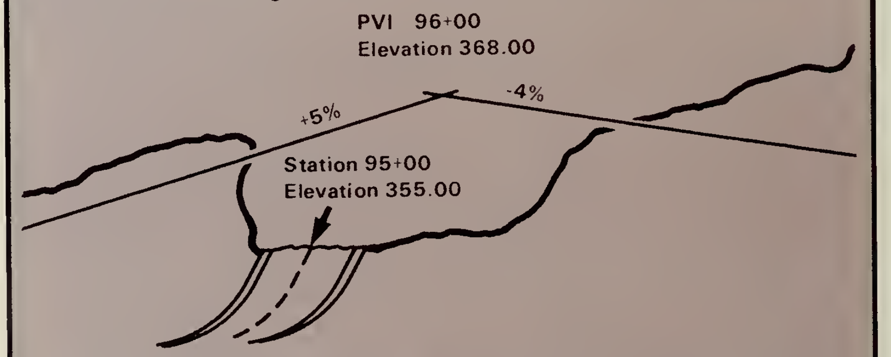
RAID PHASES

Ground Tactical Phase	How many troops will be going in? What deception plans are part of the operation (CAS, joint air attack team, feints or demonstrations elsewhere)? What time of day (or night) will the landing occur? How long will the force be on the ground? What are the contingency plans if aircraft are lost en route or at the objective?
Landing Phase	Will landing be on or away from the objective? Does the commander want to use one or multiple landing zones (LZs)? Do you want to use attack helicopters or Air Force assets to prepare the LZs? Do you want to use pathfinders to assist in landing? How many aircraft can be diverted to make false insertions, or do you want to make a series of false insertions en route?
En Route Phase	What flight corridors will be established? Can you arrange for escort aircraft (Air Force or attack helicopters)? What are the refueling and rearming requirements en route or at the objective? How are smoke and chaff used to assist in deception? Where will passage points, pilot pickup points and air control points be established?
Loading Phase	How many pickup zones (PZs) are requested? Are the air movement tables (to include the bump plan) complete? If the flight is larger than the PZ will permit at one time, where will the aircraft meet for the initial point?

Figure 1.

Engineer Problem

A new road with a PVI (point of vertical intersection) at station 96+00 and elevation 368.00 feet is to intersect an existing road whose centerline crosses the new road at station 95+00 and elevation 355.00 feet as shown below. The vertical curve of the new road must be selected to pass through the centerline elevation of the existing road.



Determine the length of vertical curve required to pass through the fixed point.

Problem/Solution submitted by Robert D. Baldwin, P.E., Roads and Airfields Branch, Department of Military Engineering.

Command Update:
130th Engineer Battalion
Vega Baja, Puerto Rico
LTC Luis M. Carrillo-Rivera
CSM Angel Birriel-DeJesus

Notes:

[1] CPT Ron Klein, "Aviation Employment in Special Purpose Operations," *U.S. Army Aviation Digest*, September 1984, p. 6.

[2] MAJ Charles L. Berry, "Planning Aviation Cross-FLOT Operations," *Military Review*, January 1984, pp. 34-45. This article provides an excellent introduction to planning considerations for cross-FLOT attacks.

[3] Carl von Clausewitz, *On War*, edited and translated by Michael Howard and Peter Paret, Princeton, 1984, p. 119.

Awards

How do you measure professional achievement?

by MAJ Jefferson J. Irvin

When I was ten and my father was stationed in France, I recall him telling a story about General DeGaulle.

One day, while reviewing the French militia, General DeGaulle entered a village. A squad-sized town force formed up for inspection. The senior officer was a heavily beribboned colonel; the second-in-command was a colorfully decorated lieutenant colonel. They were followed by a gaudy array of majors and captains—all bedecked in military finery. Last in line was a private in a plain uniform. "What's the matter with you!" DeGaulle glowered down at him. "Can't you sew?"

A unit can easily lose control of awards. I once attended a battalion ceremony where the post's championship basketball team received the same certificate of achievement as the departing NCOs. Several of the players were under indictment for drug abuse. Not surprisingly, people tittered.

If a unit is too free with awards, soldiers dismiss them. On the other hand, there is no substitute for awards that are based on objective, measurable, professional competition. They provide a highly visible tool for documenting the achievements of those who deserve early promotion, plum professional schooling, and special end-of-tour recognition.

I became a believer the hard way. While I was a platoon leader, my best squad leader left my unit without an Army-level award. The brigade staff rejected the ARCOM citation I wrote. It read something like this:

SSG Jones was the best squad leader in Second Platoon, B Company, during the period. . . . He enforced within his squad the highest standards of barracks and personal appearance. His supervision of the Darmstadt maintenance facility, the Schweinfurt dependent school, and the Wildflecken tank turning pad construction projects resulted *in the completion of these high dollar projects on time and to a high quality. He is a great credit to B Company and the United States Army.*

To me, it was a failure of personal leadership. I truly believed the man was my best squad leader. The citation, however, lacked objective evidence of achievement. My opinion alone was not sufficient to move the decision makers. I felt the rejection intensely—especially when, instead of the ARCOM, my squad leader received the same battalion certificate of achievement as the indicted basketball players that day.

How can you take care of your soldiers? How can you make sure the promotions and awards you influence don't go disproportionately to those who are adept at self-promotion, irrespective of actual performance of duty?

You can institute a command-monitored set of competitions for the company, platoon or squad that allows individuals to compete several times over a range of skills. The wider the range, the greater the probability that every individual will find a niche where he excels. Soldiers gain a sense of accomplishment. Their enthusiasm transfers to other areas, and they are more likely to reenlist. It's good for the soldier, good for the unit, good for the Army. Competitions which touch all soldiers include:

- Army Physical Readiness Test (APRT)
- NBC defense
- Land navigation/orienteering
- Marksmanship
- Weapons employment

Some competitions should test athletic skills (APRT); some should be written tests (map readings); some should be based on simple continuous expenditure of effort (personal equipment maintenance); and some should be shrewdly chosen combinations of skills (orienteering, SQT level 1 company level competitions). If the same people win every time, they may be superhuman; however, it is more likely that your competitions don't yet cover an adequate range.

By now you are saying, "Wait, this sounds administratively oppressive." But actually a routine system of competitive evaluation simplifies company supervision. It is manageable because the SQT procedure has defined objective criteria for MOS proficiency that are easily adapted for competitive testing. Tangible records on soldier performance reduce the inevitable headaches surrounding efficiency reports, promotions, selections for schooling and other contentious decisions.

Make sure everyone competes in a way that connects directly to their work (the traditional Mechanic-of-the-Month competition, for example). This is tough to accomplish considering the variety of MOSs in a company headquarters. How do you set up professional competition for the three individuals in the communications section or the two PLL clerks?

You can try one of two tacks. You can encourage the battalion to set up intercompany competitions for low density MOSs, or you can set goals the soldiers compete against. For example, have the communications personnel compete against brigade radio readiness norms that are incremented upwards to increase the challenge. When the norms are exceeded, individuals receive written recognition.

The criteria must be uniform and objective. Everyone competing must be tested under the same conditions. The evaluation criteria must be as devoid of subjective judgment as possible, as it is in the Go, No-Go SQT. Objectivity is crucial; you want competition to identify the talented, quiet and dedicated soldier who might otherwise go unnoticed among more gregarious personal favorites.

Competition may be based on announced or unannounced tests or inspections, but the award itself should not be a random event. A routine schedule of awards allows those who are competing to prepare rationally. You lose legitimacy if the Mechanic-of-the-Month award is given out sporadically in January, May and July.

Once you have competition, make sure that awards are made promptly, results are widely disseminated, and, most important, that you maintain good records.

While I was a first lieutenant, I asked my platoon sergeant, whom I admired greatly, who his best platoon leader had been. He did not, to my chagrin, flatter me but immediately named his platoon leader in Vietnam—a man who carried six notebooks into combat, hanging like medals all over him.

Why the notebooks? When soldiers performed well, he wrote on-the-spot notes that documented their achievements and won his men the recognition they deserved.

That message hit home the day my outstanding squad leader didn't receive the ARCOM I knew he deserved.

When I became a company commander I was determined not to repeat past mistakes. I established an imperfect version of the awards system described here (imperfect, in that things always become clearer in hindsight). I may have been sporadic, giving the Mechanic-of-the-Month award in January, July and September; but I kept records religiously and it paid off.

When I left, the new commander received my record of individual and unit awards, filed by individual in the company. A newly promoted staff sergeant had been the best marksman in the unit, had repeatedly bested the other NCOs in PT tests, had the best squad in ARTEP testing, and had worked on construction projects that won brigade awards. In his company file were 12 awards and letters—all from intracompany competitions or endorsements to larger unit awards. He was a quiet individual who knew his business, set high standards and made his men perform. When I met him 6 months later at Fort Belvoir, he was wearing a new Meritorious Service Medal.

MAJ Jefferson J. Irvin was an assistant professor of geography and computer science at the U.S. Military Academy in 1985. He served as a platoon leader and company commander in the 94th Engineer Battalion is Germany. MAJ Irvin has a bachelor's degree from the U.S. Military Academy and a master's degree from Stanford University. He is now a civil engineer and a major in the Army Reserve.

Engineers Join Regimental System

The Corps of Engineers will join other combat arms branches as a full participant in the Army's regimental system. The engineer regiment will be known as the Corps of Engineers.

The whole branch regiment means that all engineer officers and enlisted soldiers will be affiliated with the Corps of Engineers as their regiment regardless of their assignment.

MG Richard S. Kem, Commandant of the Engineer School, believes that the regimental plan captures and strengthens the dual sense of affiliation that engineers feel both to the Corps and to their battalion, the basic working and fighting element.

"To enhance soldier affiliation at the battalion and separate company levels, the Corps will initiate a program to highlight unit histories and accomplishments," said LTC Charles E. Olson, Chief of the Engineer Proponency Office.

Engineer officers and enlisted soldiers will wear the branch insignia. They will wear the numerical designation of their current engineer battalion above the insignia. When engineers serve in other assignments, they may elect to wear the numerical designation of one of their former engineering battalions.

The Corps' regimental home will be Fort Belvoir. When the Engineer School moves to Fort Leonard Wood in 1989, the regimental home will move with it.

The Corps is working with the Army Institute of Heraldry to develop colors and a coat of arms, or crest, that will symbolize the Corps as a regiment. The colors will be of a standard design for combat arms regiments. The crest will be worn above the right pocket on the Army green, white or blue uniform.

To symbolize membership in the Corps of Engineers, the crest will be presented to each member of the regiment, either at the Engineer Officer Basic Course graduation, Warrant Officer appointment ceremony, or Advanced Individual Training graduation. Soldiers who reclassify into an engineer specialty will receive the crest after completing an on-the-job training program or attending an appropriate military school.

The Corps regimental plan will also include designating and selecting an Honorary Colonel of the Corps and Distinguished Members of the Corps. The plan will be implemented by June 16, the Corps' 211th birthday.

Obstacles—

Engineers and Maneuver Forces Need Common Terms

Point

(continued from page 23)

engineer staff at each level provide appropriately detailed input as the maneuver plan evolves into a set of orders and control measures. If we agree on terms that let commanders clearly communicate their intent, obstacle plans will be more responsive and engineer participation early in the planning process will be guaranteed.

CPT Michael D. Baehre is attending graduate school at Rensselaer Polytechnic Institute. He has served with the 10th Engineer Battalion, 3rd Infantry Division, Kitzingen, Germany, as a platoon leader, battalion maintenance officer, company commander, and assistant division engineer. CPT Baehre received a bachelor's degree from the U.S. Military Academy and is a graduate of CAS³ and EOAC.

Engineer Solution

A. Given: PVI at station 96+00
$EL_{PVI} = 368.00$
Fixed point at station 95+00
$EL_{FP} = 355.00$

B. Procedure: The fixed point is offset from the PVI; therefore, use the fixed point formula.

1. $\Delta G = G_1 - G_2 = 5 - 4 = 9\%$
2. A = 96+00 - 95+00 = 1+00 = 1 station
3. $GLE_{95+00} = EL_{PVI} - G_1 A$
$= 368' - (5)(1)$
$= 363'$

4. $Off_{95+00} = 363' - 355' = 8'$

$$L = 2\left[A + \frac{2(Off)}{\Delta G}\right] + 4\sqrt{\frac{A(Off)}{\Delta G} + \left(\frac{Off}{\Delta G}\right)^2}$$

5. Direct substitution gives the equation:

$$L = 2\left[1 + \frac{2(8)}{9}\right] + 4\sqrt{\frac{1(8)}{9} + \left(\frac{8}{9}\right)^2}$$

$L = 5.56 + 5.18$
$L = 10.74$ stations

School News

Directorate of Combat Developments (DCD)

Thermal Sight Minefield Detection:

Testing of thermal sights on the M1, M2/3, and M60A3 tanks and the improved TOW vehicle (ITV) was conducted at Fort Knox, KY, November 18-20, 1985. Testing determined whether existing thermal sights can detect friendly and threat mines, both surface laid and buried. Evaluation results are expected by early May 1986.

M870 Semitrailer Upgrade:

Planning is underway to upgrade the M870 for transport of the T11 dozer. TRADOC is assessing operational requirements to ensure that all M870 deficiencies are considered. This list is based on an M870 system assessment and on contact with three combat heavy engineer battalions as representative users of the vehicle. Deficiencies associated with the M870 are also being identified and will be considered for repair and/or upgrade.

Ground Emplaced Mine Scattering System (GEMSS):

The GEMSS program was approved for fielding in FORSCOM and USAREUR. A total of 55 systems will be fielded in USAREUR according to a materiel fielding plan published October 1985. Initial deployment of 22 systems began in January 1986.

The M74 AP mine will not be available until fourth quarter, FY 86.

Cleared Lane Marking System (CLAMS):

The CLAMS and mounting kit for M60 tanks were type classified *standard* on September 30, 1985. The first unit equipped is scheduled for third quarter, FY 87.

The mounting kit for the M1 Abrams tank is being worked as a product improvement to the CLAMS and is scheduled for introduction into the force by third quarter, FY 88. The separate adapter is required to deflect high exhaust temperatures from the M1 turbine and to provide a unique interface with the Abrams odometer/speedometer system.

Engineer Force Structure:

Several important engineer force structure changes were approved by the Chief of Staff of the Army on November 5, 1985. Engineer initiatives in this review include the redesign of engineer combat heavy battalions and engineer topographic battalions, restructure of the 20th Engineer Brigade (Airborne), and recovery of ten roundout companies to the active component. An NTC engineer company with 200 spaces was resourced during the force structure review.

Minefield Reconnaissance and Detector (MIRADOR):

Prototypes of MIRADOR will be tested side-by-side at Fort Knox in late FY 87. This will define the state of the art in mine detection and capitalize on multisensor systems to improve accuracy, reliability and speed. Although initiated as a concept exploration, MIRADOR is the first engineer program that fits AMC's *Proof of Principle* streamlined acquisition cycle. If successful, close-in detection of mines will improve.

Reserve Component Advisory Staff (RCS)

USAR School EOAC Program:

The Winter 1985 issue described the 14-week EOAC-RC course and its two-week modules. Both of these options are still available, but there is a new USAR school version.

The USAR school EOAC program started October 1, 1985. The new course is divided into four phases. Phase 1 consists of common subjects. Phases 2, 3, and 4 consist of engineer-particular subjects.

Phase 1 can be taken at a USAR school, inactive duty training (IDT), or by correspondence. Phases 2 and 4 must be taken on active duty at Fort Belvoir. These two phases cannot be taken by correspondence. Phase 3 is available by correspondence.

The new USAR school EOAC-RC is now the only EOAC-RC taught by the USAR schools. The new EOAC-RC phases equate to the old phases as follows:

New EOAC-RC Phase	Old EOAC-RC Phase
1	I, III
2	VI
3	IV, II
4	V, IA

For more information, contact your USAR school, your Personnel Management Officer at ARPERCEN (800) 325-4987, or the RC Advisory Staff at Fort Belvior (800) 336-3095, extension 4166.

ARPERCEN:

A new organization, ARPERCEN, was created when RCPAC and ARPERCEN combined on November 5, 1985. ARPERCEN is a field operating agency of the Office of the Chief, Army Reserve (OCAR).

School News

Defense Mapping School (DMS)

Cartography Courses:

A redesigned Basic Cartography Course (BCART) for MOS 81C places greater emphasis on map revision techniques using the Zoom Transfer Scopes (ZTS). The course, implemented last fall, retains instruction in map base construction and color separation. The course has been shortened from 56 to 53 academic days, and the number of classes has changed from 10 to 5 per year.

The Advanced Cartography Course (ACART) has also been redesigned. Implemented in January, this course is 41 academic days.

Department of Military Logistics (DML)

CMF 63 Subfield Restructure:

A revision of the special purpose equipment repair subfield in CMF 63 has been approved. The revision will improve the overall maintenance of power generation, engineer construction, utilities, quartermaster, and chemical equipment. It will also enhance the utilization, supervision, promotion opportunities, career progression, professional development, and retention of soldiers in the affected MOS.

The revised subfield establishes a new "capper MOS" of 52X (special purpose equipment repairer) for use only at skill level 4 (E-7). It will be the capper MOS for 52C (utilities equipment repairer), 52D (power generation equipment repairer), 52F (turbine engine driven generator repairer), and 63J (quartermaster and chemical equipment repairer).

The revision realigns the career progression of:

- MOS 62B—construction equipment repairer. At skill level 4, 62B presently is fed by 52C, 52D, 52F, and 62B. The revision eliminates the feeder MOS progression for the 52 series. 62B will progress from skill level 1 through 4.
- MOS 63J—quartermaster and chemical equipment repairer. 63J presently progresses from skill level 3 (E-6) into 63H (track vehicle repairer) at skill level 4. The revision redesignates all 63J skill level 3 positions as MOS 52C. Skill level 3 for 63J will be eliminated after TAADS documentation and personnel reclassification are complete.

The new MOS data for 52X reflects in the October 1985 update to AR 611-201, *Enlisted Career Management Fields and Military Occupational Specialties*. Personnel reclassification guidance can be obtained from Commander: USAMILPERCEN, ATTN: DAPC-EPL-O, 200 Stovall Street, Alexandria, VA 22332-0400.

Directorate of Training and Doctrine (DOTD)

Doctrine and Tactics Training (DTT):

The New Equipment Systems Division coordinated Doctrine and Tactics Training (DTT) to coincide with the mid-February fielding of the M9 armored combat earthmover. The training teaches the combat capabilities of the M9 and gives doctrine for employing the equipment.

The DTT provides guidance to the first unit equipped with the M9, the 13th Engineer Battalion, 7th Infantry Division, at Fort Ord, CA.

Formerly called New Organization Training, DTTs are a vital part of the TRADOC/AMC systems support strategy for fielding new equipment.

Department of Military Engineering (DME)

Construction Management Training:

Mobile training teams (MTTs) in construction management are available from the Engineer School. These teams consist of subject matter experts who will instruct, observe and evaluate both active and reserve component engineer units. Primary services offered are assessment of construction management proficiency and presentation of training to acceptable standards.

Units desiring MTT assistance should contact SFC Richard Brown, Nonresident Training Division, DOTD, (703) 664-3008, AV 354.

Units that conduct their own training on construction management can obtain exportable training packages (ETPs) from the Engineer School. The ETPs consist of student workbooks, lesson plans and student practical exercises. Lessons are also available on video cassette or a 33mm slide/cassette recorder combination.

For more information on these construction management ETPs, contact CPT Chuck Horn or CPT Tim Devens, DME, (703) 664-3272, AV 354.

The Engineer School has purchased several software packages in project management. The purchases were based on extensive evaluation of software on the market today and information from the Construction Engineering Research Laboratory (CERL).

For more information on these software packages, contact CPT Chuck Horn, DME, (703) 664-3272, AV 354.

School News

Directorate of Evaluation and Standardization (DOES)

Lessons Learned:

Two Lessons Learned products are available from the Engineer School.

- *Task Force Engineer, Combined Arms Integration Package*—designed to assist the engineer unit in combined arms training. It offers some train up ideas for units preparing for an exercise and a sample briefing to assist in starting an early working relationship with maneuver commanders and staff. Units identified to attend an NTC rotation have already been sent a copy of this package.
- *NTC Lessons Learned Quarterly Newsletter*—offers a condensation of combined arms lessons learned from observation at NTC.

Requests for Lessons Learned products should be sent to Commandant, USAES, ATTN: ATZA-ES, Stop 271, Fort Belvoir, VA 22060-5271. POC is CPT Craig Tavani, AV 354-4172.

TRADOC USAR Schools Affiliation Program:

The Engineer School and five USAR schools became formally affiliated October 1, 1985. The affiliation program ensures TRADOC and FORSCOM that USAR school instruction is of excellent quality and conducted by competent instructors using the best and most current instructional materials.

The Engineer School is affiliated with:

- 1155th USAR School, Edison, NJ
- 2059th USAR School, Bethlehem, PA
- 2070th USAR School, Fort Belvoir, VA
- 2071st USAR School, Owings Mills, MD
- 2072nd USAR School, Philadelphia, PA

New Directions for EOT:

The Engineer Orientation Team (EOT) has taken steps to provide even better service to engineer field units. When preparing for a visit, the team asks the unit commander and his staff for ideas, issues and concerns. The EOT staff then tailors the team to the unit's needs by gathering subject matter experts from the directorates and training departments of the Engineer School.

The EOT visits units—battalion and above— every two years, but commanders may request a visit from the team at any time. The Engineer School encourages reserve component engineer units to submit requests for an EOT visit.

Requests should be addressed to the Director, Directorate of Evaluation and Standardization, Stop 271, Fort Belvoir, VA 22060-5271 or call SFC David M. Rexrode, AV 354-3668.

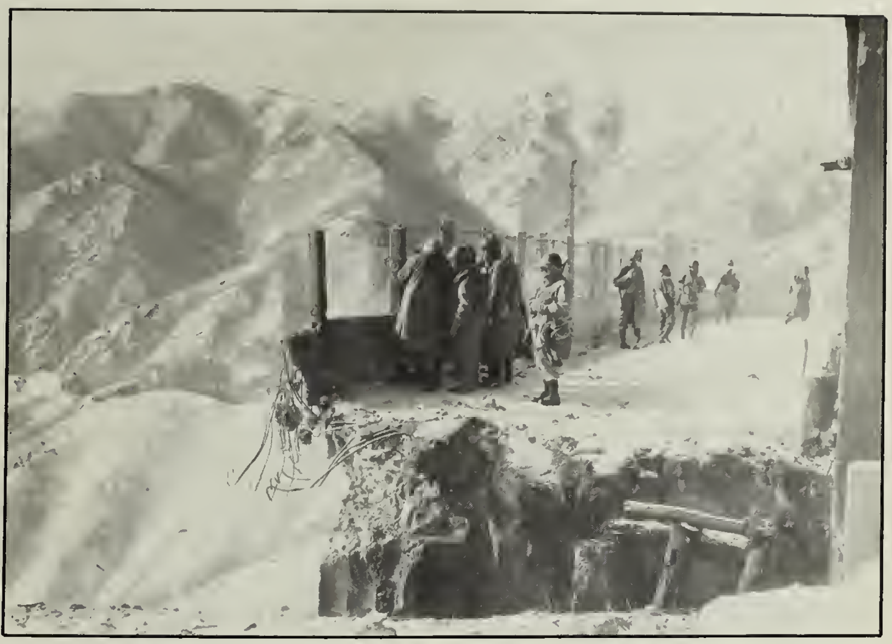
Correction:

EOBC/EOBC-RC Class Schedule FY 86

The report date for class 7-86 is 10 August 86.

Past in Review

by Dr. William C. Baldwin
Historical Division, OCE



The 58th Engineer Treadway Bridge Company experimented with airdrop techniques to span this 22-foot gap during the retreat from the Chosin Reservoir, December, 1950. Photo: U.S. Marine Corps

Engineers in the Korean War: The Bridge at Koto-ri

When the North Korean army attacked South Korea in late June 1950, it quickly pushed the surprised South Korean and American forces into the southern tip of the Korean peninsula around Pusan. The Inchon Landing behind North Korean lines in September launched a United Nations counteroffensive which drove North Korean forces toward the Yalu River, the border with Communist China.

As part of this counteroffensive, American troops landed on the eastern coast of North Korea in October and moved north to the 4,000-foot plateau around the Chosin Reservoir. In late November, Chinese troops launched a massive counterattack which forced United Nations units to withdraw from the frozen, rugged terrain of North Korea. U.S. Army engineers played an important part in this withdrawal.

Surrounded by Chinese troops, the 1st Marine Division and elements of the 7th Infantry Division fought their way south from the Chosin Reservoir to the village of Koto-ri. Fourteen thousand troops, including 2,000 from the Army, had to withdraw over a narrow road which dropped over 3,000 feet through a treacherous pass.

About three miles from Koto-ri, the road ran along the side of a steep cliff and crossed a bridge next to a gatehouse. The gatehouse covered four steel pipes which carried water from the reservoir to the turbines of a power plant in the valley below. Because the gatehouse had no floor, the bridge was the only means for crossing the steel pipes.

Recognizing the importance of the bridge, Chinese troops had destroyed the original bridge and two replacements built by Army engineers, leaving a gap of 22 feet. Withdrawal of American vehicles, tanks and guns required spanning this gap.

Marine and Army engineers concluded that bypassing was impossible and that the small assembly and launching space, in addition to enemy fire, ruled out the use of a Bailey bridge. Although they had never tried the technique before, Army engineers decided to experiment with parachuting sections of a treadway bridge from the air.

The 58th Engineer Treadway Bridge Company was in Koto-ri, and two of its bridge trucks were operational. Only two days were available for experimenting with the airdrop techniques. On the first day, the tests failed when the bridge sections crashed to the earth. An Air Force expert on airdrops had larger parachutes flown in from Japan during the night, and the airdrops on the second day were successful.

On December 7, Air Force C-119s released eight treadway sections—twice as many as needed—over Koto-ri. Only one section was damaged when its parachute failed to open. Engineers loaded the sections onto the 58th Bridge Company's trucks and on December 9, rebuilt the abutments and laid the treadways in three hours. Throughout the night, a steady stream of troops and vehicles crossed the span, headed for the port of Hungnam and evacuation to the south.

Rumors about the bridge near Koto-ri brought American journalists to the site, and their dramatic reports made the span, according to the Marine Corps account of the campaign, "the world's most famous bridge for the moment." Some stories were fanciful, implying that the treadways had parachuted into position on the abutments. Yet the reality was still impressive. Engineers devised an innovative solution to a tactical problem, tested it in a short period of time, and applied it under difficult circumstances. The bridge at Koto-ri played an important part in the legendary Marine withdrawal from the Chosin Reservoir.

Suggestions for further reading:

E. L. Rowny, "Engineers in the Hungnam Evacuation," *The Military Engineer* 43 (Sept.-Oct. 1951): 315-19.

Lynn Montross and Nicholas A. Canzona, *The Chosin Reservoir Campaign, U.S. Marine Operations in Korea, 1950-1953* (Washington, D.C.: Government Printing Office, 1957).

ENGINEERS AT VALOGNES
by John Scott

U.S. Army Center of Military History

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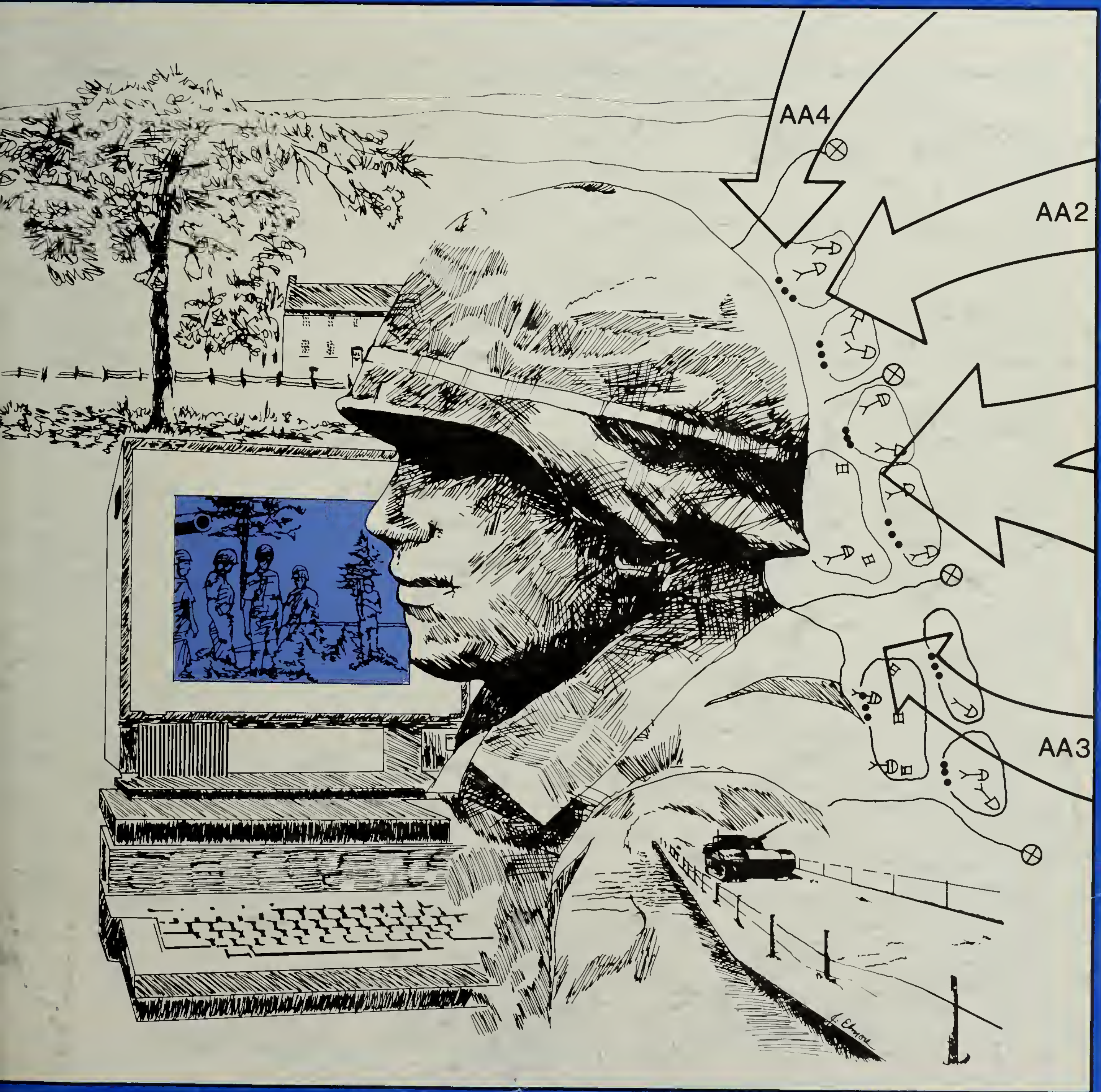

NEW HORIZONS AND LESSONS LEARNED

SCHOOL MOVE RIVER CROSSING LATIN AMERICA
TRAINING AUTOMATION AIRFIELD DAMAGE REPAIR

Military Engineering—Art or Science?

A Personal Viewpoint

by MAJ David J. Block and MAJ Gary W. Baumert

If every situation in combat is unique, so is the mind each engineer brings to battle. Doctrine provides the intellectual framework we use to think about military operations. However, having mastered the tenets, we are tempted to lockstep into schoolbook solutions—to become obsessed with the recipe rather than the result. As engineer officers, we can add flexibility and muscle to Army doctrine by applying personal judgment to the professional knowledge we bring to the battlefield.

In AirLand Battle, the fog of battle demands initiative. Time will rarely be on our side. We must free ourselves from thinking that we can lay perfect minefields . . . that we can solve problems by applying alluring formulas and tidy rules . . . that we will have sufficient resources on hand to do everything by the book. We must free ourselves to dream . . . to postulate "What if?" . . . to practice engineering as an art as well as a science.

For example, imagine your engineer company is supporting a forward infantry battalion defending against a Soviet motorized rifle regiment. Your warning order says that a major Soviet thrust is expected in four hours. The battalion is defending the brigade's critical left flank. Your sector is a 1,500-meter frontage with gently rolling hills. Two hard-surface roads divide the battalion into three distinct areas. There are no natural obstacles. This is not a location the battalion would choose to defend. But it is integral to the brigade and division defense strategy and must be held.

The battalion commander says he needs three minefields straddling the two roads that delay and channelize the enemy, but preserve the roads for counteroffensive. Brigade has allocated 900 M75 mines for use with your GEMSS dispenser to support the battalion. Additional mines cannot be resupplied before the attack. RAAMS and Volcano may become available following the attack.

This is the type of desperate situation where the military's greatest asset is our personal ability to apply imagination and ingenuity to doctrine and engineering practice.

Applying emplacement principles for GEMSS-delivered minefields (detailed in FM 20-32), you have resources for only two three-belt, .005 density minefields—not the three requested by the battalion commander. How do you accomplish the mission with the assets at hand?

The engineer reconnaissance team reports that all three areas must be mined for the defense to hold. Your options are shaped by enemy tactics, terrain, and time available. In this case you might consider—

- Varying the linear density across the front, keeping the same depth, and emplacing two belts instead of three.
- Laying two lower-density minefields and one standard minefield.
- Varying the linear density across the front by emplacing two belts instead of three, and varying the depth of the minefield.

Despite the shortage of mines, you see an opportunity to outwit the enemy by using the third option. You can cover the frontage with three two-belt minefields, but space the two belts so that the threat is forced to deploy and regroup. A sample solution in FM 20-32 recommends gaps of 50 to 100 meters between belts. You know the Soviets' minefield-breaching technique is basically to use rollers and plows to clear a lane 400 meters long, based on the premise that a U.S. minefield is generally 300 meters deep.

Since the threat expects to breach 400 meters and clear the minefield, a second belt placed at least 400 meters behind the first could deceive him.

Theoretically, he will hit the first belt, breach 400 meters, think he has cleared the minefield, and resume the attack formation. He then encounters the second belt. His options are to bull through with direct tank losses to mines or resume clearing with prolonged exposure.

This option deviates from FM 20-32's guidelines on spacing belts, but preserves the intent of the minefield to delay, disrupt and channelize the enemy forces, making the threat more vulnerable to fire.

You brief the commander on the potential benefits and cost:

"Sir, I propose we lay three minefields with two standard-density belts instead of three. The two belts will provide uniform protection across the entire front. By preserving the density, the probability for an initial hit is the same as for a three-belt minefield. Fewer total mines means fewer tank losses to the minefield if the threat bulls through. However, we increase the delay factor and disrupt the momentum of the attack—regardless of whether he breaches or bulls—by spacing the belts so we create the effect of a second minefield."

Any example is necessarily general and oversimplified. But the point remains. Every engineer leader is challenged by the specific requirements of the mission and tactical situation to imaginatively apply, bend and mold the formulas and rules. In order to exploit opportunities to fix the enemy or turn disadvantage to advantage, we must be well-grounded in the concepts of AirLand Battle and masters of engineering science, techniques, tactics, and procedures. But as we

(continued on page 48)

Engineer

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UNITED STATES ARMY ENGINEER CENTER AND FORT BELVOIR, VA

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On the Cover

Simulation and automation are revolutionizing the Engineers' approach to training.

Art: Jeanne Elmore

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AT URBANA-CHAMPAIGN

DEPARTMENTS

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CLEAR THE WAY

by MG Richard S. Kem, Commandant, U.S. Army Engineer School

Engineers on the Battlefield

When training is sanitized, combat engineers suffer.

Too often, the way we train the combined arms team emphasizes the obvious. Training constraints—budget, environment, maneuver damage—eliminate terrain obstacles, friction and battlefield reality. The *dirty* battlefield is sanitized, and realism suffers.

Too often, the victim of that cleansing is the combat engineer. The importance of his battlefield role and contribution to the combined arms team is lost when *white tape* substitutes for obstacles . . . when units are pressed to continue maneuver—despite obstacles—to meet exercise timetables . . . when demolitions and digging are not allowed.

Map exercises and modeling that obviate the vertical dimensions of terrain or see the battlefield in 2.5-kilometer spatial increments also diminish the complexities of maneuver and hence the engineers' value to the team. While warfight models recognize the benefits of obstacles and survivability positions, they don't actively play the engineer effort. They generally assume the engineers can do the job—that the obstacles are in place and the maneuver forces are dug in. The magnitude of the engineer effort required to provide responsive support—C^2, manpower, time, materials—is overlooked.

Mobility, countermobility and survivability missions are easily downplayed when these factors have no assigned win-lose value. In this context, the misunderstandings of our maneuver commanders at company team, battalion task force and brigade are understandable. Unfortunately, such misunderstandings could prove critical—if not fatal—in future conflict.

For example, our AirLand Battle doctrine with its tenets of initiative, depth, agility and synchronization depends upon our ability to maneuver and sustain that maneuver as we take advantage of battlefield *windows of opportunity*. But windows of opportunity easily become *windows of vulnerability* if our maneuver commanders don't fully appreciate battlefield reality, the effects of terrain, or the threat's ability to deny us maneuver.

The National Training Center—in that desert environment—provides the most realistic training battlefield yet . . . one that focuses Army interest on our combined arms ability to fight. With environmental constraints removed, the battlefield is not sanitized of factors that contribute to friction, delays and failures. Success depends on how well the commander synchronizes all elements of his force.

The realism is such that, in the words of the former FORSCOM Commander, GEN Robert Sennewald: "The Army has rediscovered the importance of the combat engineer to combined arms battlefield success."

Even as we understand the reality of NTC and the outstanding opportunity it provides for combined arms training, we must all understand its limitations:

- The desert environment does not approximate the terrain of Germany where forests, built-up areas, defiles, rivers, and streams hinder movement and change the ways engineers contribute to battle.
- The NTC in essence trains at armor and mechanized infantry task force level. Brigade headquarters are exercised in C^2 of two subordinate task forces, but it is the armor or mechanzied task force that is fully challenged by the factors of METT-T, particularly enemy and terrain.
- Brigades continue to take augmented engineer rotation packages to NTC.

Because of these limitations, the challenge and complexity of providing comprehensive engineer support to larger maneuver units is not well understood. Since the engineers' ability to support larger forces—division and corps—is seldom practiced, there is considerable underestimation and misunderstanding of the limitations upon current engineer organizations in providing responsive support throughout all levels of the force.

The challenge to corps, division and brigade engineers is to work with their maneuver commanders to create field training exercises that

BRIDGE THE GAP

by CSM Matthew Lee Jr., U.S. Army Engineer School

Are You Ready for the First Battle?

If you are challenged to win the first battle tomorrow, do your soldiers believe you will see them through? Have you convinced your subordinates in the garrison and in the field that they should trust their lives to your leadership?

While engineer NCOs are making substantial contributions to readiness, we can do more . . . more to be technically and tactically proficient in our minds and professional in our hearts.

To be all you can be, the basics of soldiering must be a sixth sense—something that comes instinctively. When the APC breaks down, what will you do? You are on your own. Do you know without a doubt in your mind how you will accomplish the mission?

When that private says, "What do we do, Sergeant?" his life is riding on your answer.

Can you assemble and disassemble your weapon in your sleep? . . . Clean and repair it in a heartbeat? Are you ready to use a map and compass? Can you dig a foxhole correctly without hesitation? Are you fit, today, to endure a 15-mile forced march with the infantry? Forget that the Army PT minimum standard is 2 miles. Are you ready to survive? These are fundamentals that save lives.

As an engineer leader, you must be a master of all you survey—professionally proficient to teach every aspect of your business. Teach it! That's the fundamental test. What you know well enough to teach, you ***know***.

If you don't have the training, set pride aside and get it. Ask questions and refer to the manual until you've got the skills down cold—mobility, countermobility, survivability, equipment, weapons, demolitions, NBC, physical fitness.

Then spend time training your soldiers. In combat, your soldiers will do instinctively the things you demand they do right in training. See that they exceed the ARTEP and fitness standards. Those standards are minimum—the jumping off point where you begin.

The more you teach them, the more confidence they will have in themselves and in you . . . the better prepared they will be to entrust their survival to your hands.

Confidence is the key to winning. The Sapper Leader Course helps instill that warrior spirit in engineers. But not everyone gets to attend. Let's not wait for the Sapper Leader Course to be our crowning glory.

Go out and grab it . . . seize the initiative . . . create your own opportunities. Nothing short of excellence will win the first battle.

CSM Matthew Lee comes to the Engineer School from Hawaii where he was the command sergeant major for the 65th Combat Engineer Battalion, 25th Infantry Division (Light).

---

fully expose battle commanders and operational and logistics staffs to realistic battlefield situations.

We must also ensure that the maneuver commanders we train understand that friction, terrain, threat capabilities, and Murphy's Law—if disregarded in training or discounted in importance—will make a combined arms unit, which seemed well trained on the *clean* battlefield, ripe for exploitation in time of war.

The FTX and CPX remain the premier opportunity to experience the rigors, distance, pace and lethality of today's battlefield. Our challenge is to benefit and build on the lessons and experience gained. We must train to grow stronger—not as engineers—but as the *combined arms team.* Combined arms is the *key* to winning.

School News

Engineer Personnel Proponency Office (EPPO)

SGA Restructure Deletes MOS 51C:

The Engineer Personnel Proponency Office has forwarded an MOS restructure plan to the Soldier Support Center, National Capital Region, to delete MOS 51C (structures specialist) from the Army's inventory.

This deletion is necessary because the onslaught of prefabricated materials eliminates the need for higher level technical expertise found in MOS 51C.

MOSs 51B (carpentry and masonry specialist) and 51K (plumber) will absorb the duties previously performed in 51C. MOS 51B will inherit the structural tasks—such as erecting prefabricated buildings—while 51K will assume the tasks of pipeline construction and metalworking. Current 51C authorized positions will be converted to MOS 51B or 51K depending on each specific mission. No authorized positions will be lost as a result of this deletion.

Personnel now holding MOS 51C will be reclassified before October 1986.

Reduced Spaces for ADM Specialists:

The Engineer Personnel Proponency Office is working with the U.S. Army Military Personnel Center to meet a force reduction in MOS 12E (ADM specialist).

A reclassification team from MILPERCEN and EPPO visited Europe and reclassified 234 of the 257 MOS 12E soldiers assigned to USAREUR. The remaining 23 soldiers were not reclassified because they had received assignment instructions for drill sergeant or recruiter, or were leaving the Army. Representatives from MILPERCEN and EPPO visited Fort Leonard Wood and Fort Hood to brief 12E soldiers on plans for their MOS.

EPPO is reviewing several proposals. A standards of grade authorization (SGA) restructure will ensure that soldiers in the specialty are competitive for promotion.

Because of the sensitive nature and unresolved problems of this issue, it is impossible to clearly project the future of engineer ADM missions or to establish milestones for the force structure.

Questions concerning MOS 12E may be addressed to: Commandant, U.S. Army Engineer School, ATTN: ATZA-EP, Fort Belvoir, VA 22060-5248. The point of contact is SFC Michael R. Mudge, (703) 664-2287, AV 354-2287.

Topographic Engineer Position Filled:

The Engineer Personnel Proponency Office recently filled the subject matter expert position for CMF 81 (topographic engineering). EPPO now has an expert for each engineer career management field. Questions, comments, or suggestions about CMF 81 can be addressed to: Commandant, U.S. Army Engineer School, ATTN: ATZA-EP, Fort Belvoir, VA 22060-5248. The point of contact is MSG Carlos Sellers, (703) 664-2287, AV 354-2287.

Department of Military Logistics (DML)

New FTX for AIT Soldiers:

The Department of Military Logistics has initiated a field training exercise for advanced individual training in MOSs 52D10 (power generation equipment repairer) and 52F10 (turbine engine driven generator repairer).

The department created a realistic FTX training site complete with administration buildings, direct fire lanes, and permanent tent pads. The FTX uses three training scenarios—a reconnaissance patrol, an aggressor attack, and a chemical attack.

Soldiers participate in the FTX during their seventh week of technical training at Fort Belvoir. MOS-specific skills learned in the classroom are integrated with basic combat survival skills throughout each FTX cycle. Each soldier is tested on 26 of the 30 common skill tasks from the SMART book. Soldiers also receive 22 hours of technical training on site.

The Department of Military Logistics continues to improve its FTX program and plans to include MOS 52C10 (utility equipment repairer) during FY 87.

School News

Defense Mapping School (DMS)

MICROFIX V2.1 Training Package:

The Defense Mapping School will soon begin teaching MICROFIX V2.1, topographic configuration software. The Department of Topographic Sciences will use MICROFIX V2.1 to teach terrain analysts (81Q) and topographic engineers (21C) computer-assisted terrain analysis techniques.

Topographic engineers supporting the battlefield commander will use MICROFIX V2.1 to—

- Store, alter, and retrieve weather and terrain information.
- Enter current data into weather information files.
- Use DMA digital terrain elevation data (DTED) to produce line of sight plots, color-tinted elevation maps, weapons/sensor masking plots, slope maps, and three-dimensional oblique views of the terrain.
- Provide battlefield environmental effects on military operations for long- and short-term planning.

For more information, write: Director, Defense Mapping School, ATTN: TSD-AT, Fort Belvoir, VA 22060-5828. The point of contact is CPT McGregor, (703) 664-2978, AV 354-2978.

Directorate of Training and Doctrine (DOTD)

New Field Manuals:

New training and doctrine field manuals available this year include:

FM 5-335, *Drainage*—Planning, designing and constructing drainage facilities in the theater of operation.

FM 5-25, *Explosives and Demolitions*—Types and characteristics of explosives and demolition methods.

FM 20-32, *Mine/Countermine Warfare*—Planning, coordinating and executing mine/countermine operations.

FM 5-541, *Military Soils Engineering*—Evaluating soil conditions, predicting soil behavior and solving problems related to military operations.

FM 5-277, *Bailey Bridge*—Methods of assembly and maintenance, bridge components, loading and transporting, and special applications of the Bailey bridge.

These field manuals can be ordered from the U.S. Army Adjutant General Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220-2896.

Lineman's Handbook:

Do you have a 52G in your unit? These soldiers need *The Lineman's and Cableman's Handbook,* which has replaced TM 5-765. Units authorized the 52G MOS can still get one free copy.

Send the property book officer's name, Department of Defense activity access codes, and document number to: Commandant, U.S. Army Engineer School, ATTN: ATZA-TD-P-CR, Stop 291D, Fort Belvoir, VA 22060-5291.

After initial distribution, units must purchase copies from the publisher, McGraw Hill Book Company, New York.

Reserve Component Advisory Staff (RCS)

Reserve Officers Advanced Courses:

The new U.S. Armed Forces School—formerly the U.S. Army Reserve School—is going strong. However, some engineers confuse the *phases* of the Armed Forces School course with the *modules* of the Engineer School course.

- The Armed Forces course contains four two-week phases; two are available by correspondence.
- The Engineer School course contains seven two-week modules; none are available by correspondence.

You must decide which course you want to pursue and stay with it. You cannot mix the two courses. If you are enrolled in the old USAR seven-phase course, you must stay with it.

The new Armed Forces course has four phases:

Phase	Type of Course
I	Correspondence or USAFS at home station
II	Active duty on AT, ADT, FTTD (two weeks at Fort Belvoir)
III	Correspondence
IV	Active duty on AT, ADT, FTTD (two weeks at Fort Belvoir)

The Engineer School course has seven two-week modules which are all taught at Fort Belvoir.

Students must know which courses they have already taken when they report for class. Otherwise, delays result; and in some cases students are sent home because the block of instruction they need isn't being taught when they report.

For more information, call the Reserve Component advisory staff at (703) 664-4166, AV 354.

New USAR Advisor:

COL Joseph Cushieri is the new USAR advisor to the Engineer School. He comes to Fort Belvoir from the Army War College.

News & Notes

Engineers join the Army's regimental system

The Corps of Engineers officially joined the Army's regimental system at Fort Belvoir, June 23, 1986. Corps colors and crest were presented at the ceremony where the honorary colonel and honorary sergeant major of the Corps were introduced.

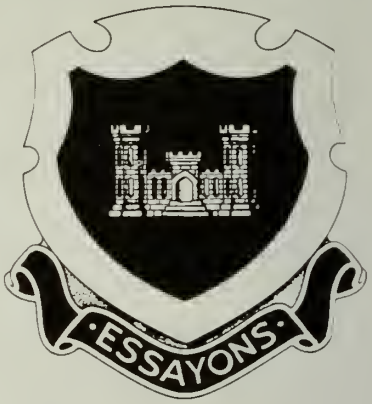
LTG Frederick J. Clarke, honorary colonel, and SGM Leon Van Autreve, honorary sergeant major, both retired, were chosen because of their distinguished service to the Corps of Engineers and the Army.

The first unit crests were presented to four outstanding engineers:

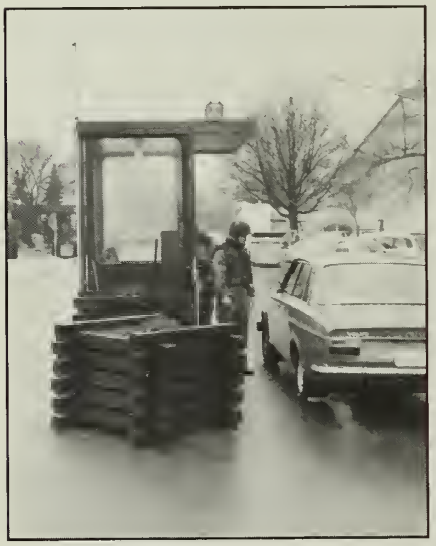
- SFC Dennis J. Ansay—winner of the 1986 Sturgis Award given to the Corps of Engineers top NCO—Company B, 237th Engineer Battalion.
- SFC Michael M. Balch—Drill Sergeant of the Year for Fort Leonard Wood—Company B, 2nd Battalion, 3rd Brigade.
- SSG Salvador Heridia—NCO of the Year for the Corps of Engineers—USA FESA.
- SSG Patrick Mahone—NCO of the Year for both Fort Belvoir and First Army—Company C, 11th Engineer Battalion.

All soldiers will receive the unit crest when they complete their primary engineer training.

The crest, designed by the U.S. Army Institute of Heraldry, reflects the traditions of the Corps of Engineers. Members of the Corps will wear the crest centered on the pocket—above the name tag or any unit citations—on the Army green, blue or white uniform.



Log cribs protect post



Developed in Germany, these log cribs provide inconspicuous security against terrorists.

As worldwide terrorism increases, European military communities are caught in the dilemma of providing adequate security without restricting free movement. In Heilbronn, West Germany, the Directorate of Engineering and Housing uses residential log cribs as an innovative defense against terrorists.

Cheap, effective, and quickly produced—using 4x4s and 16d nails—these log cribs can be built in any shape. Once in position, they are filled with earth and double as planters for flowers and shrubs.

Though easy to build, these barriers are proven vehicle-stoppers and give excellent cover to soldiers on guard duty. They provide protection for potential targets like officers clubs, youth activities centers, family housing areas, and bachelor officers quarters.

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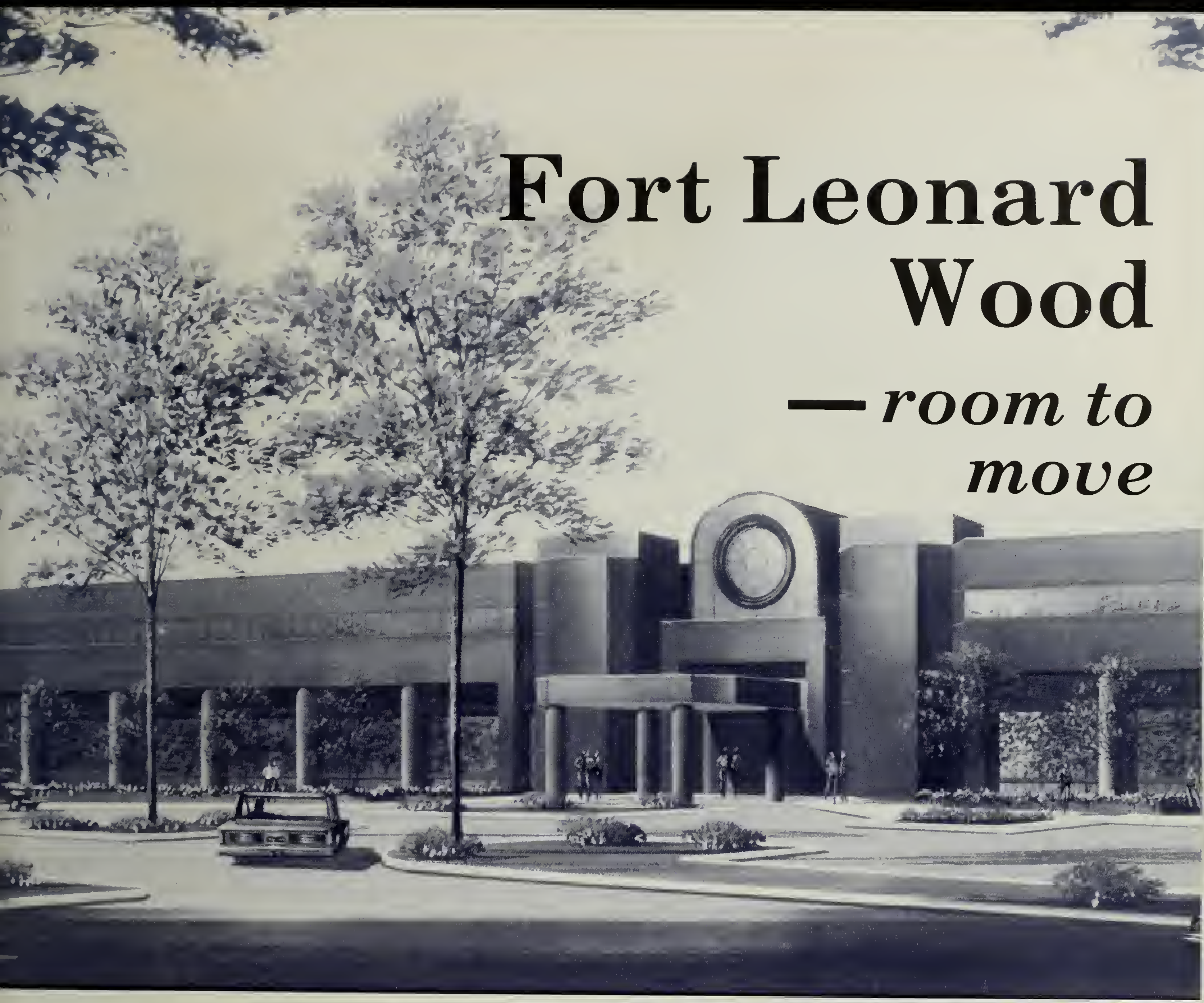
Soldiers from A Company, 307th Engineer Battalion (Airborne), practice the buddy rappel—a technique for rescuing wounded soldiers—while training at Camp Merrill, GA.
The 307th also acted as OPFOR for soldiers completing the mountain phase of ranger training.

Photo: Ruben Maestas

Fort Leonard Wood

—room to move



by LTC Richard L. Montgomery

Some say moving the U.S. Army Engineer School is like building a boat while being swept down a raging river. The analogy reflects the dynamics of relocating to Fort Leonard Wood by 1989.

The move realizes a long-standing dream to create a true engineer center where officers and NCOs from all engineer MOSs can train together—a campus specifically tailored to engineer requirements.

The dream is alive in the era of Gramm-Rudman-Hollings budget cuts because it makes long-term economic sense. In addition to cutting costs by consolidating training, the Corps of Engineers headquarters and other military agencies now leasing offices in Washington, D.C. will save money by moving to Fort Belvoir.

The move will generate anticipated savings of $23 million in annual recurring costs. By this fall, Congress should decide whether to approve the first phase of a $64 million military construction package which would allow work to begin in early FY 87.

When the Engineer School was established at Fort Belvoir in 1917, it accommodated both officers and enlisted engineers. But as demand for engineers grew, we outgrew Fort Belvoir. In 1941, most enlisted specialties transferred to Fort Leonard Wood.

Today, most engineer officers are assigned to Fort Belvoir twice in their careers—for engineer officer basic and advanced courses—while most NCOs serve repetitive tours at Fort Leonard Wood. Because few engineer officers or NCOs are ever assigned to the other post, the possibilities for interaction are limited.

We want the synergy that comes from sharing a common campus—an advantage our armor, infantry and artillery counterparts already enjoy.

Four of our primary battlefield missions—mobility, countermobility, topography and survivability—focus on terrain. We need room to move. Fort Leonard Wood offers that. While engineers at Fort Belvoir have to journey 66 miles to Camp A.P. Hill for field training, Fort Leonard Wood offers 62,910 acres on post, including 19,000 acres of impact area.

When training is colocated, officers and NCOs will be able to train together on common field exercises.

For example, they might plan, layout and construct a base camp or put in a primitive (forward) airfield.

There are 300 live fire and demolitions ranges within minutes of the classroom.

A man-made lake has been created for bridge training, and there are opportunities for fast-water obstacle training on the Big Piney River.

Airfield damage can be simulated at an abandoned airfield.

There are 37 other training areas and bivouac sites, with room for expansion to accommodate modern engineer equipment systems like the M9 ACE.

To heighten realism, a mix of engineer TOE units will be restationed to Fort Leonard Wood so that skills and equipment reflect the entire spectrum of the engineer corps.

Plans for the move are being orchestrated by the Engineer Center Transition Office at Fort Leonard Wood in coordination with the Engineer School and TRADOC.

Five new facilities will be built: a headquarters, an academic facility, a training aids support center, a library, and 346 unaccompanied officers billets. To move by 1989, everything must be complete except the library and training aids support center which will open in the last half of the year.

The move should begin in early FY 89 when engineer proponency transfers to the commandant of the Engineer School at Fort Leonard Wood and the Military District of Washington takes control of Fort Belvoir.

Officer training will begin with classes in June 1989. Throughout the transition, a normal student load will be maintained—with adjusted FY 89 class dates creating a 60-day window to allow for the move.

A small contingent of the basic technical courses taught by the Defense Mapping School for MOSs 81C, 81Q, 82D, and 83F will remain at Fort Belvoir. Also, training of MOSs 52C, 52D, and 52F will come under the proponency of the Ordnance School October 1, 1987. Later, the Ordnance School will assume command and control of the 1st Engineer Battalion, which becomes the 809th in September.

At Fort Leonard Wood, officers and NCOs will be able to train together. This artist's concept shows the 346-billet unaccompanied officers quarters, one of five buildings planned. Others include a headquarters, an academic facility, a training aids support center, and a library.

Training for lieutenants will markedly improve. They will train most often in the field—applying the combat engineering, construction and leadership techniques learned in class to tactical situations. They will be able to practice basic soldiering skills such as camouflage, dispersion and movement. Interactive computer-based training will increase opportunities for self-development. EOBC platoon trainers will be used as instructors for small group training.

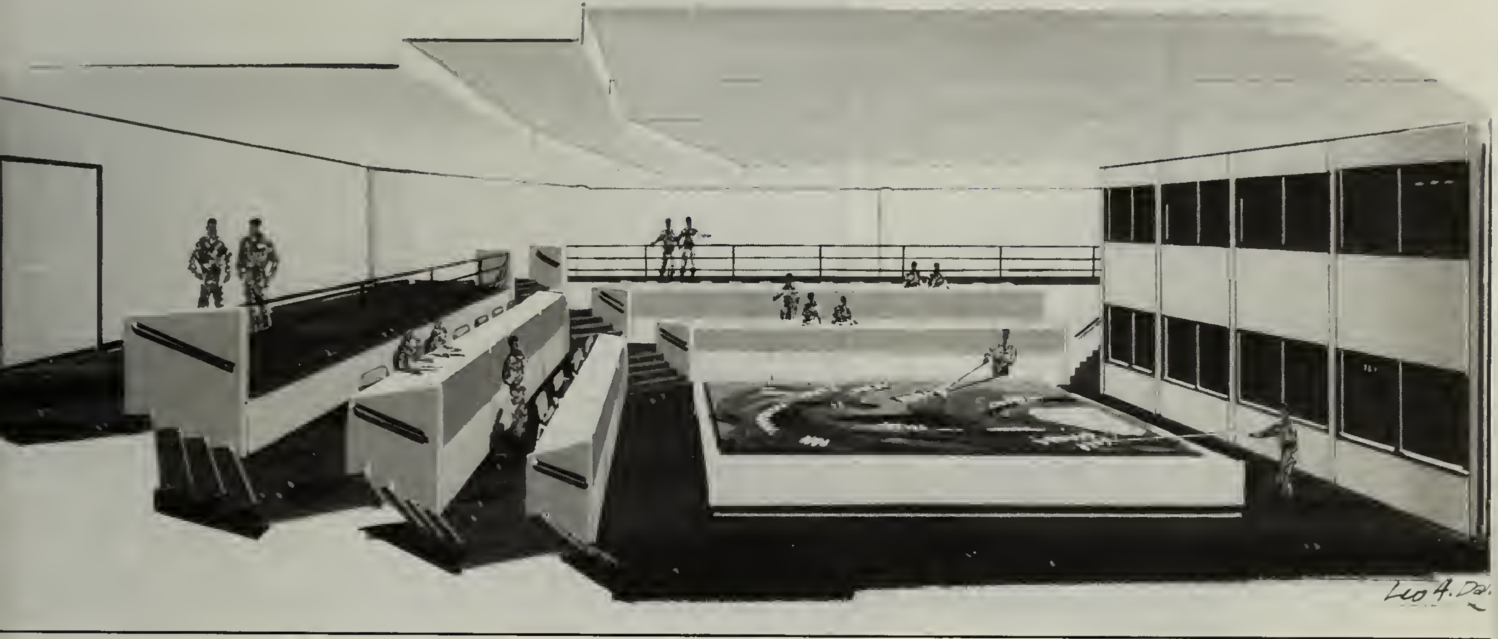
NCO training groups will also be smaller—1 instructor for 12 students—and rely heavily on hands-on experience, field exercises and opportunities for leadership. ANCOC will focus on the platoon. Because 47% of all E7s serve in other positions, other primary responsibilities will also be highlighted.

The NCO Academy will be part of the U.S. Army Training Center and will continue to handle drill sergeants school, the primary leadership development course and BNCOC common core instruction.

The Engineer School move is a once-in-a-lifetime opportunity to design and build a facility that incorporates the latest developments in training technology and computer-based instruction. The result will be an Engineer Center tailored to train military engineers for combat.

LTC Richard L. Montgomery is the Engineer School transition coordinator at Fort Belvoir. A military intelligence officer, he last served as chief of threat analysis, HQLANDSOUTH, Verona, Italy, and has had two tours within TRADOC. He was commissioned from Infantry OCS and graduated from CGSC. He has a bachelor's degree from William Jewell College and a master of education degree from Boston University.

Engineer Tactical Training Center NEW DIMENSIONS at Fort Leonard Wood



by Mariellen Steece

An engineer tactical training center planned for the Engineer School will add new dimensions to training.

The two-story, multimedia, multipurpose auditorium is being designed to harness new technologies for training military management and tactics. It will also accommodate conferences and seminars.

The auditorium will seat 70 students at desk consoles equipped with high-resolution video monitors and interactive computer capability. Soundproof glass booths along the back walls will serve as staff cells for TOCs during combat simulations.

Students will hone their skills using computers, video terrain displays and simulated field communications. Programs and briefings could be projected onto a large retractable central screen.

The terrain board in the middle of the room can be molded by a digital data base to resemble Korea, the Middle East or other common scenarios. Eventually, holograms may be used to project military units over the terrain.

Several exercises could be run simultaneously from the training center's control booth. This means students working on a battalion maneuver exercise to defend in sector could generate data for a brigade task force exercise in the next booth.

Computer-assisted CPXs and video tutorials of tactical training exercises without troops (TEWTs) will help students gauge the success of their tactics and the consequences of their decisions. The training possibilities are limitless. Students could participate in:

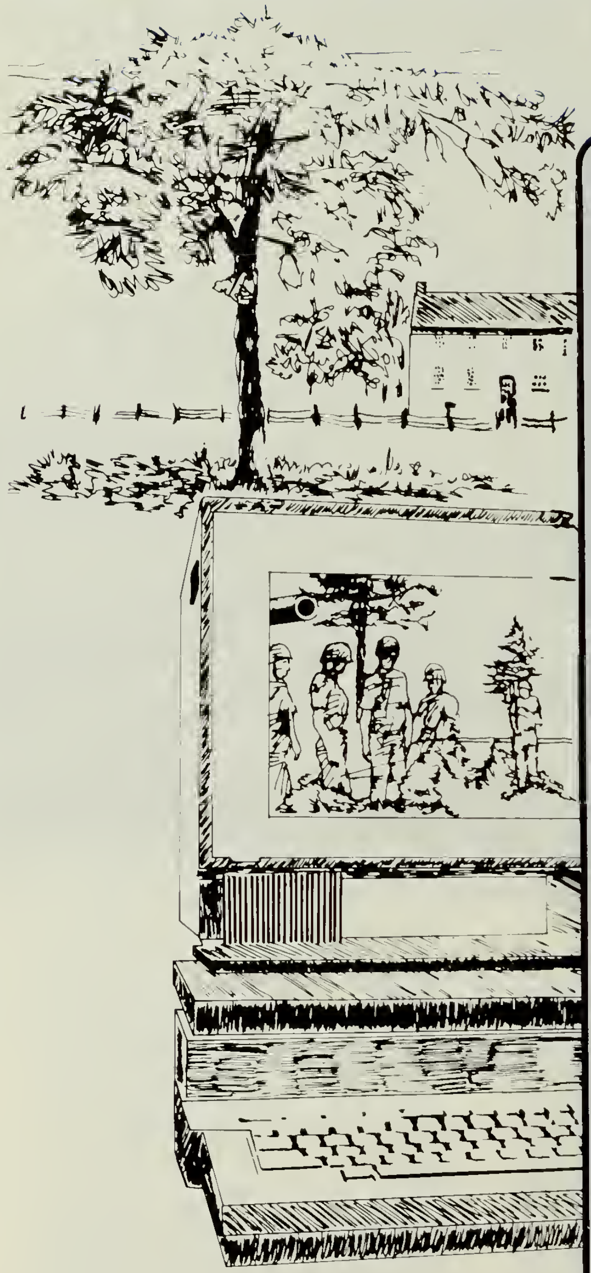
- Simulated terrain walks viewed on interactive video discs.
- Engineer command and control system exercises and engineer staff estimates.
- Modules on how to read contour maps for lines of sight, or on weapons and equipment recognition.

At night, students will be able to continue practicing in their rooms at terminals that are linked to the tactical training center information bank.

Plans also call for the tactical training center to be linked to Fort Leavenworth's Combined Arms Training Activity's simulation center, allowing engineers to participate in joint exercises with other TRADOC schools. It will also connect with Army information networks like TACTICSNET for students' research on tactical concepts.

Mariellen Steece, chief of the Training Technology Office at the Engineer School's Directorate of Training and Doctrine, designed interactive video disc-based tactical training simulations and microcomputer-based training for the school for four years.

Simulation **What if?** Training



Task Force Engineer

Training Package: Task Force Engineer interactive video disc — The Manassas battlefield tactical exercise without troops.

Scenario: The battalion task force is preparing to defend Dulles Airport against remnants of a motorized rifle regiment.

Frame 27, Situation 4: The Team Tank commander appears on the video display screen and addresses the student.

"Good afternoon, lieutenant. I've been expecting you. The S-3 wants you up to speed on Team Tank's responsibilities, so prepare to take notes. In addition to my mission to fire into the battalion engagement area (vicinity, Robinson house), I must be ready to counterattack southeast and then west across the ford in the 8299 grid square and envelope the enemy's right flank.

I need countermobility support in the armored kill zone and survivability for my TOW's tank and APCs. I need mobility sup port for the counterattack. I wan at least one engineer squad wit me during that portion of th operation.

Now, let's walk the section an talk specifics. Since your platoo is in direct support of the tas force, can you attach a squad t Team Tank for the counterattac mission?"

Computer Prompt: Yes or No?

Answer: No. You cannot attach or suba locate a unit that is in direct support o another.

Team Tank Commander: *"Now let' look at the ford in my sector. want you to give me a one-wa passage across that ford. In othe words, I want to get across fro my direction, but I don't want th enemy crossing from his. Ca you do it?"*

by George Larson

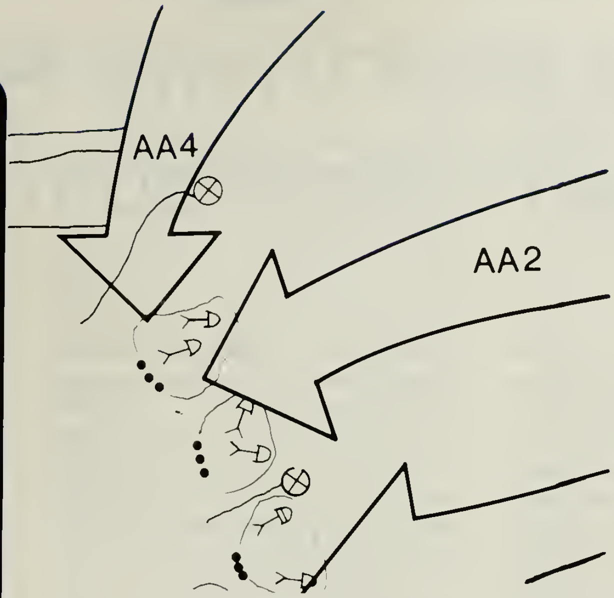
Interactive video discs are rapidly changing the way engineers train for battle. By next year, engineer lieutenants will be able to call up a simulated battlefield on the Army's electronic information delivery system (EIDS) and practice task force engineer missions.

They will get practice in preparing engineer plans and work estimates currently available only to those engineers at EOBC and EOAC who participate in battlefield tactical exercise.

These students travel 35 miles from Fort Belvoir to Manassas to walk the terrain with Engineer School instructors. At the end of the day, they brief the task force commander—giving him their best recommendations for constructing obstacles, developing attack routes, ensuring survivability, and clearing fields of fire.

While a computer simulation can never fully duplicate field reconnaissance experience, interactive video disc training offers several attractive advantages for engineers:

- Experience that active and reserve engineers can get anywhere they have access to EIDS.
- Self-paced instruction that gives students a chance to revisit sites, rethink possibilities and review the exercise at a later date.
- Individualized learning that can't be dominated by a few students



Camera pans view of the fording site.

Computer Prompt: What recommendations do you have for this requirement?

A. Put in a road crater and use the AVLB.

B. Use FASCAM to cover it.

C. Tie in a triangular tank ditch with mines and obstacles.

D. Put in a road crater or an antitank ditch and breach it when necessary with an engineer squad.

Student answer: D.

Computer prompt: How long do you think that would take? Come on, try again!

Student answer: C.

Computer prompt: OK, that just may work allowing the friendly force through, but being too steep for the enemy.

and that accommodates different levels of expertise in map reading, land navigation and engineer work.

During Task Force Engineer, tactical commanders and the battalion engineer will brief the students from the microcomputer screen while the students listen and take notes. They then accompany the engineer on a reconnaissance of the defense sectors—discussing the mission and engineer support requirements.

Each possible weapon or defense position is recorded on film so students can call up a 180° to 360° pan of the terrain. Students can access a compass or terrain map sections for orientation. An engineer estimate worksheet is available at a keystroke to accumulate data and calculate the estimate.

The computer asks drill questions as terrain is reviewed to reinforce terrain analysis skills and evaluates the estimate as it is prepared to help students gauge their understanding of task force engineer concepts.

A map reading portion of the exercise allows students to try their hand at a preliminary obstacle plan and work estimate—calling up enlarged grids of the battlefield. The computer will prompt them with questions and check their terrain orientation. As the student reviews terrain features and chooses obstacle emplacements, the computer poses questions to help evaluate his decisions.

After the map reconnaissance, the terrain walk module gives the student a chance to practice land navigation skills. He reconsiders his plan in light of actual terrain conditions like trees that obscure site lines or mud in the stream bottom—limitations not readily apparent from a map.

When the student finishes the terrain walk, he takes a short self-test on the computer before he prepares a final engineer estimate, a briefing for the task force commander, a warning order for the platoon sergeant, and a time line allocating equipment and personnel for the engineer missions.

Task Force Engineer offers just a glimpse of the possibilities for multimedia, interactive video disc simulations in military training.

The Engineer School currently has proposals in the works for interactive simulations including:

- Brigade Engineer — a planning exercise for engineers in support of the brigade task force.
- Gap Crossing — an exercise to evaluate a division commander's concept of operation and to plan crossing support.
- Bridge Construction — an exercise on how to lay out a site and build a bridge, piece by piece.

The Army has just begun to tap the opportunities of this technology.

George Larson is a computer programmer for the Training Technology Office of the Directorate of Training and Doctrine at the Engineer School.

Simulation **What if?** **Training**

Computers Create Bridge Between Classroom and Field

by E. Joseph Griminger

It began in the 1960s when the military first used computer driven flight simulators to train pilots and astronauts . . . simulators that imitated reality when actual experience was hazardous, expensive or time-consuming.

Today, the Engineer School relies increasingly on computers to make more efficient use of instructors and improve student performance in the engineer officer advanced course.

In the past decade, the word "simulation" has become nearly synonymous with "computer." But simulations are not limited to the electronic medium. The FTX is the granddaddy of Army simulations, but there are also classroom and written simulations.

Computer simulations create a bridge between classroom instruction and field experience—reinforcing basic strategies taught in class so time isn't wasted relearning basics during FTXs. The Army can concentrate its field exercises on honing higher level skills and judgments.

Interactive computers allow students to make decisions and observe the immediate consequences—both negative or positive. Free of inhibitors like danger, cost and time constraints, students ponder "What if?" and explore the ramifications. By examining the alternatives, they come away with a more comprehensive understanding of both problems and solutions.

For example, the school currently uses an NBC simulation to reinforce decision-making skills essential for reconnaissance in areas contaminated with nuclear and chemical agents.

The student's goal is to lead a small patrol through the contaminated areas and return to base camp without casualties.

Students move the patrol around the grid using the keyboard. Options to the right of the grid allow the student to perform tasks such as:

- Change MOPP levels.
- Administer first aid.
- Send NBC reports.

> ***Free of inhibitors like danger, cost and time constraints, students ponder "What if?" and explore the ramifications.***

Students can also retrieve information concerning contamination levels. They can select these options any time the patrol isn't moving. Messages, feedback and a submenu are displayed in the area above the grid. The heat meter to the left of the grid indicates the risk of heat casualties caused by working in MOPP gear.

The patrol automatically halts when it encounters NBC contamination, giving students a chance to make decisions that avoid casualties and safeguard the mission.

They have complete freedom of choice. But just as in real life, there are no second chances. The entire patrol is lost if a student fails to mask immediately upon encountering nerve gas.

Several patrols may be wiped out before students master survival strategies. However, unlike the real world, a simple keystroke restores the patrol and the computer repeats the simulation.

Most students first try the NBC simulation after classroom instruction—practicing and reinforcing procedures and tactics learned in class. The interactive nature of computer play stimulates questions that would otherwise go unasked when the class meets again.

Two other simulations are now part of the growing library of courseware at the Engineer School.

The obstacle planning simulation was developed by the U. S. Army Construction Engineering Research Laboratory. It allows students to develop an obstacle plan by placing obstacles on an intricate computer-generated map. Once in place, a simulated battle wages on the screen to test the effectiveness the plan.

An engineer staff estimate simulation is being developed by the Directorate of Military Engineering for use with the obstacle simulation. Students will use the simulation to master complex decision-making processes involved in developing the engineer staff estimate. They then check their effectiveness against the battle scenario for the obstacle simulation.

These simulations currently run only on the Engineer School's Cyber/PLATO mainframe system. However, an MS-DOS version of the NBC simulation is almost ready to run on IBM-compatible microcomputers. Simulations that run on microcomputers promise reduced costs and increased access for the engineer community.

E. Joseph Griminger is a computer-based instruction specialist at the Training Technology Division of the Directorate of Military Engineering at the Engineer School.

Laser Video Disc for 62N NCOs

by Margaret C. White

Construction equipment supervisors will soon use interactive video discs to practice basic supervisory, management and technical skills.

The computer simulation—currently being tested at the Engineer School—is part of the 62N BNCOC course. Eventually, all 62N NCOs will be able call up the simulation at their unit once microcomputer and laser disc hardware for the electronic information delivery system (EIDS) is fielded.

This will be a boon to heavy equipment operators who are promoted to staff sergeant and given supervisory responsibility before they attend BNCOC.

The 62N Construction Equipment Supervisors training package has a video disc and student guide with job directives, maps and notes. Video sequences let students solve problems they are likely to encounter on the job.

For example, the platoon sergeant in the video gives the students a mission: build a ½-mile road leading to a heliport. The students then work with the computer making choices about supply support, medical support, maintenance support, status of personnel and equipment, time frame, security, and grid coordinates. The first sergeant on the video critiques the students' choices as they go.

The video then takes students on a simulated route reconnaissance—showing motion pictures of the road and terrain. Students also look at the job site to determine where they should place the equipment park and command post.

They use the computer to report back to the platoon sergeant who critiques their plans—showing video sequences of problems they have overlooked. Would a truck get stuck because the bridge clearance is too low? Could a bridge collapse because it couldn't carry the weight of the equipment?

The students then have a chance to watch work in progress at the job site—identifying problems with equipment operation. For example, Is the dozer making the guide cut too deep?

Half the trick of being a good supervisor is the ability to anticipate. The 62N Construction Equipment Supervisors video disc program teaches students to foresee problems before real lives and heavy equipment are at stake. NCOs can learn from their mistakes, before mistakes become costly.

Margaret C. White is an education specialist for the Directorate of Training and Doctrine at the Engineer School and the project manager for the 62N video project.

C^2MUG — Free Software for Computer Users

by CPT Leo J. Fontana

If you want to reap the benefits of microcomputer-based automation, C^2MUG—an Armywide information exchange—exists to help you.

C^2MUG is the nickname of the Command and Control Microcomputer Users Group, sponsored by the Communications-Electronics Command (CECOM). The idea is to let soldiers share programs they create to help manage military missions or to pass on successful adaptations of commercially available software.

Programs of special interest to military engineers include:

- The automated construction management system.
- The engineer status program.
- The combat engineer mission management module.
- A deskmate utility with calendar and scheduling.

These programs run on an IBM personal computer (or compatible). Programs are available for the Apple II, IIe, and other types of computers.

You or your unit can join C^2MUG at no obligation or cost. Services include:

- A monthly bulletin on automation news.
- A semiannual software catalog of free user-created, floppy disc-based programs in the public domain. (The only charge is for blank diskettes.)
- Assistance with automation problems.
- An annual command and control microcomputer seminar at Fort Leavenworth.

The Engineer School reviews many of the programs offered by C^2MUG and has established a software library at the USAES computer lab (phone: (703) 664-3953, AV 354). Students may use the library to review programs and copy them onto their own floppy discs.

To request a membership, write: Chief, CECOM MCD, ATTN: AMSEL-FL-MCD (C^2MUG), Fort Leavenworth, KS 66027-5600; or call: (913) 684-7550, FTS 753, AV 552.

CPT Leo J. Fontana is chief of the Technology Applications Branch of the Directorate of Mililtary Engineering at the Engineer School.

We change our tools; then our tools change us.

Technology Aids Training

by Beverly Lloyd

Electronic technology—microcomputers, artificial intelligence, interactive multimedia video discs, and satellite network communication links—are revolutionizing the Army's approach to training soldiers.

Imagine a fully integrated exercise that joins together students from the Army, Air Force, Navy, and Marines: Army and Marine student ground commanders call for artillery and Naval gunfire . . . Air Force students control air support . . . logisticians from all services conduct resupply planning and operations.

Today, it is a dream, but technology has placed the possibility of joint training simulations within reach.

The Army is committed to supporting research to tap the latest technology to nurture the tactics, terrain and leadership skills that are essential to success in battle.

The Army began fielding standard hardware for video-disc and computer-based training to the TRADOC schools last fall.

The new electronic information delivery system—called EIDS—will eventually be available Armywide at every soldier's unit—active and reserve.

They will use EIDS to study at their unit—ordering the computer-based instructional materials they need to assist them. The new technology gives soldiers more control over their education and professional development because they won't have to wait to attend school to take advantage of training.

Studies are also underway to establish expert data banks of information that put a military expert a phone call away or an artificial intelligence on line to answer questions by providing data from its host computers.

Soldiers will also be able to communicate with instructors and other students when taking correspondence courses.

By the year 2,000, the Army should see the day when a computer gives new recruits—active and reserve—diagnostic tests so they can test out of training if they already have the skills.

Much of their education will be self-paced, following a prescription of lessons tailored to their personal needs and career goals.

Computerized records of their skills, training and proficiencies would be continuously updated throughout their careers.

As electronic networks expedite communication between military schools and field units, changes to training and doctrine can be accomplished more quickly—making everyone more responsive to the challenges of our rapidly evolving Army.

Beverly Lloyd is an education specialist in the Training Technology Office of the Directorate of Training and Doctrine at the Engineer School. She is project manager and designer of the interactive video disc, Task Force Engineer.

Simulators for Military Engineers

A variety of simulators and automated devices will add realism to mine, countermine, counterobstacle and construction training in the decade ahead. Here's a sample:

The **Placed Training Mine**—an inert working replica of standard service mines—will let soldiers practice arming and disarming procedures and simulate mine warfare for combined arms exercises. A safe, audible response will warn when errors are made that would detonate a live mine.

The **Modular Pack Mine System Simulator** will give realistic hands-on training on how to arm, operate and disarm MOPMS.

Devices to improve operator training on the GEMSS and Volcano are being considered, plus devices that simulate the effects of FASCAM in mine warfare.

The **MICLIC Trainer M136** will teach how to use line charges to breach and neutralize minefields since the rocket-projected live demolition charge cannot be routinely fired in peacetime. The trainer will also help teach preventive maintenance skills.

The **CEV Video Disc Gunnery Trainer** and the **CEV 40mm Subcaliber Device** will help gunnery crews develop their skills. The CEV video disc will train crews in target acquisition and burst on target techniques. The CEV subcaliber device will provide inexpensive training rounds that meet safety requirements for most ranges.

A **Heavy Equipment Simulator** is being considered to provide operators a safe, cost-effective platform for construction equipment training.

An **Operator Maintenance Trainer**—a portable device that supports preventive maintenance checks and services—is being considered.

Latin America:
Where the action is

> *"Engineer commanders take note: Latin America is to engineer units what the National Training Center is to maneuver, and more. The sum of the tasks challenge and frustrate even the most talented leaders. But by the end of the mission, we've seen, smelled and felt our way through the complexities of project coordination thousands of miles from home station. Rarely in peacetime do engineers have the opportunity to plan realistically in such detail."*
>
> *—MAJ James E. Brink, USSOUTHCOM,*
> *Engineer Operations and Plans, 1985*

by Victoria McAllister

Those sentiments are shared by most engineers returning from Latin America whether they have been—

- Erecting bridges or repairing schools, clinics and community centers in isolated areas of Costa Rica.
- Cutting roads and drainage systems through the jungles of Panama's Azuero Peninsula to open markets previously accessible only on foot or horseback.
- Building roads, airstrips and an emergency power plant for the air base used by U.S. forces in the outer reaches of hot, dusty Honduras.

Since 1985, combat engineers from active and reserve components throughout the United States have been deploying to Latin America for training. Their heavy construction projects—called nation building—assist the people and democratic governments of developing countries.

In return, engineers gain experience in how to prepare for overseas deployment and build projects under tight deadlines in tropical environments. In most cases, they do without what they forget to pack—be it a crane or jumper cables.

The Army also trains and tests evolving doctrine on the use of soldiers and engineers in low intensity conflicts.

The engineers have learned some hard lessons and gained invaluable experience.

Planning, Design and Bills of Materials

Prior planning is critical to produce a quality engineer project. While engineer commanders understand this, nonengineer decision makers often must be educated. Time, money and effort spent early pay big dividends—insuring a clear mission statement and solid design. All U.S. command levels must approve the mission statement and design so the scope of the project is within the constructing unit's capability.

Design must drive the bill of materials. Any attempt to develop the bill of materials without a design will lead to construction problems.

To provide adequate drainage, commanders must conduct thorough reconnaissance with host nation representatives before, during and after the rainy season. Otherwise, culverts, outfalls, headwalls, and bridge supports may not stand up to seasonal rains. Commanders must seek out terrain and climate studies and use them.

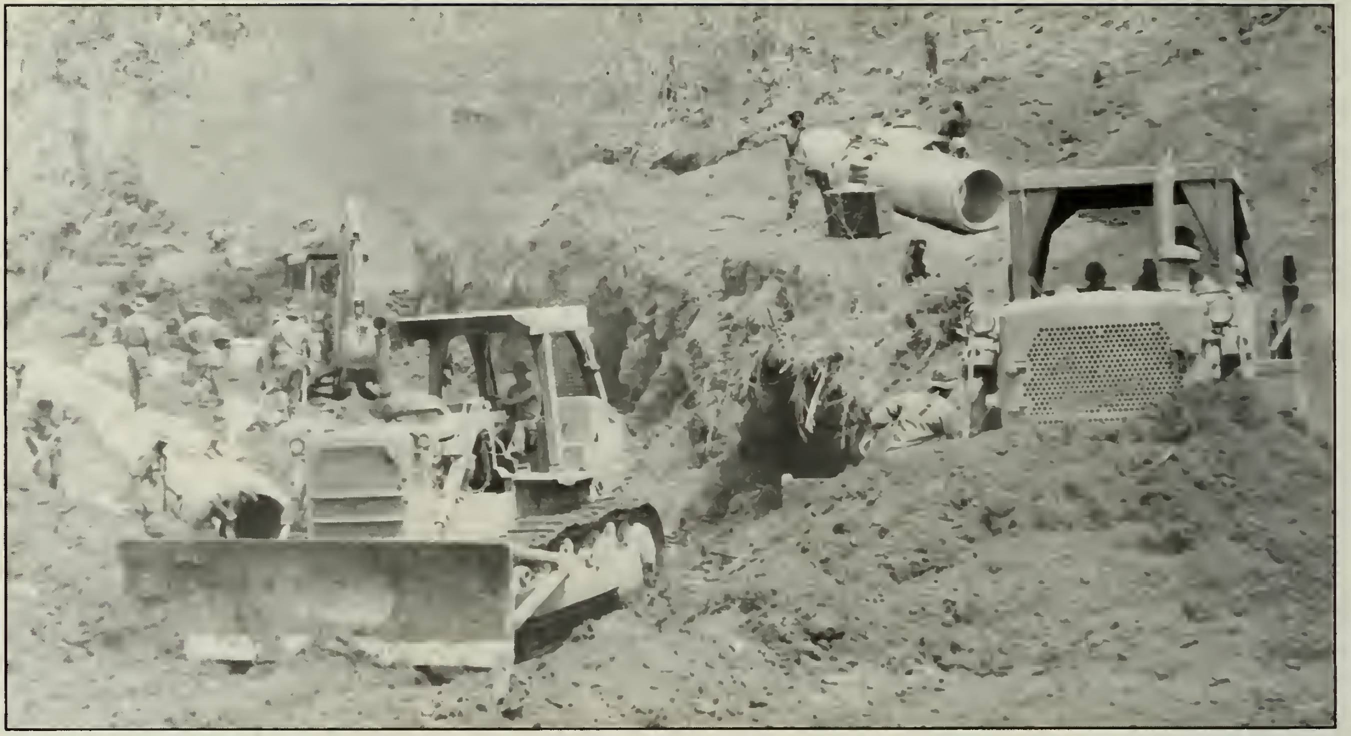
Realistic Scheduling

Before deployment, engineer reconnaissance helps determine the scope of work and project duration. In one exercise the centerline for a road was not marked, and the team was unable to make a true and accurate assessment. They didn't take into account the massive sidehill cuts and blasting requirements or the number of ford sites to be improved.

Projects must be based on a thorough reconnaissance with host nation representatives. Planners must consider the time allotted, the experience of the soldiers, the equipment available, the terrain, and the weather.

Don't accept a project sight unseen or without the construction materials on hand. It is better to decline a mission than to promise and not deliver. Be conservative in your

> *"The problem is the training is so ideal . . . the conditions are so real . . . that subsequent training back in the States may seem anticlimactic and boring . . . Nothing is simulated. The engineers get a job and do it. When book solutions don't work, they rely on good old engineer ingenuity."*
>
> *—CPT Kenneth W. Moore, 123rd ARCOM,*
> *Rio Indio, Panama, 1986*



The 135th Engineer Group, Missouri National Guard, installs culvert on the Azuero Peninsula in Panama. Here, two bulldozers cut into the harsh jungle terrain.

Tropical thunderstorms were one obstacle engineers overcame while constructing a bridge over Rio Indio in Panama.

estimates . . . If you manage to do more, everyone will be pleased. Allow time for inevitable delays for parts, fuel or the unforseen. Tell the host nation right up front what is possible and what help you will need.

Coordination

A host nation liaison officer is essential when coordinating with military and local authorities to quickly review and approve design and construction changes. He should be attached to the task force immediately upon arrival to advise the commander on local customs, traditions and weather.

Coordinate with the host nation and logistical support element during prior planning to make sure projects won't be delayed because materials aren't delivered. Anticipate and plan around social and political events in the host nation that could affect your construction schedule.

Establish a controlling headquarters early to coordinate all deployment during prior planning. At one site, logistical support elements arrived before the base camp was built or the access road was prepared.

Equipment

Sometimes vital equipment must be borrowed from other battalions. It must be in top condition before deployment because parts are difficult to come by in Latin America. In one case, two bulldozers—that would have been invaluable—arrived needing rock guards and new tracks.

Lending units must take extra care to repair equipment and verify that all issued parts are in place. To avoid unpleasant surprises, bor-

Fighting rain and the river, the 205th Engineer Battalion, Louisiana National Guard, constructs the Rio Negro bridge in Panama.
Photo: CPT Daniel B. Miles Jr.

rowing units should inspect all equipment thoroughly before they sign for it. Otherwise, the unit could be stuck with equipment that is unusable and in need of repairs before it is returned.

Make sure you take enough spare parts and equipment to remain operational. For example, if you need 10 dozers to do the job in a month, you may need to take 13 to keep 10 working at any one time.

Maintenance

We cannot dictate what resources a host nation allocates for maintenance. But the unit should get formal written agreement on the amount and type of maintenance the host nation will provide after construction is complete.

Victoria McAllister is the features editor of ***ENGINEER*** *Magazine.*

The 196th Aviation Company sling loads a backhoe for the 27th Engineer Battalion. The engineers worked on the Mocoron airstrip in Honduras during Cabanas '86.
Photo: James Mitchell

The Mine Effects Simulator

REALISM

by Dianna K. Green

A mine effects simulator will be tested this fall by the Armor and Engineer Board at Fort Knox, KY. Fielding of the simulator is slated for FY 90.

Engineer commanders and trainers have long been frustrated by the lack of realistic mine simulation in force on force, free play maneuvers.

A recent functional area analysis concluded that the Army's inability to simulate mine and countermine operations degrades combat readiness.

For example, the National Training Center uses a combination of fire markers, observers, painted wood blocks, plastic devices, air burst simulators, and smoke grenades to simulate the use of mines. None of these give attackers and defenders a realistic appreciation of mines and their effects.

The Engineer School is committed to developing a mine effects simulator that will strengthen maneuver arms and engineer training.

The Jet Propulsion Laboratory, California Institute of Technology, has designed a mine effects simulator. It is compatible with the multiple integrated laser engagement system—used to simulate combat strikes with other weapons. The mine effects simulator also smokes and flashes for use in non-MILES training. The new simulator is available in antipersonnel (Figure 1) and antitank (Figure 2) models.

During training, mine effects simulators will be emplaced like real mines. When a tank hits the pressure-activated tilt rod or trip wire, the simulator gives an acoustic

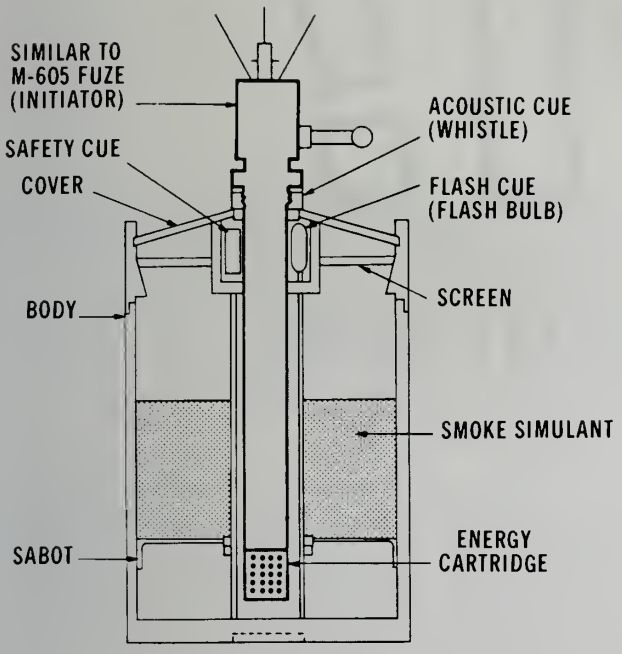


Figure 1.

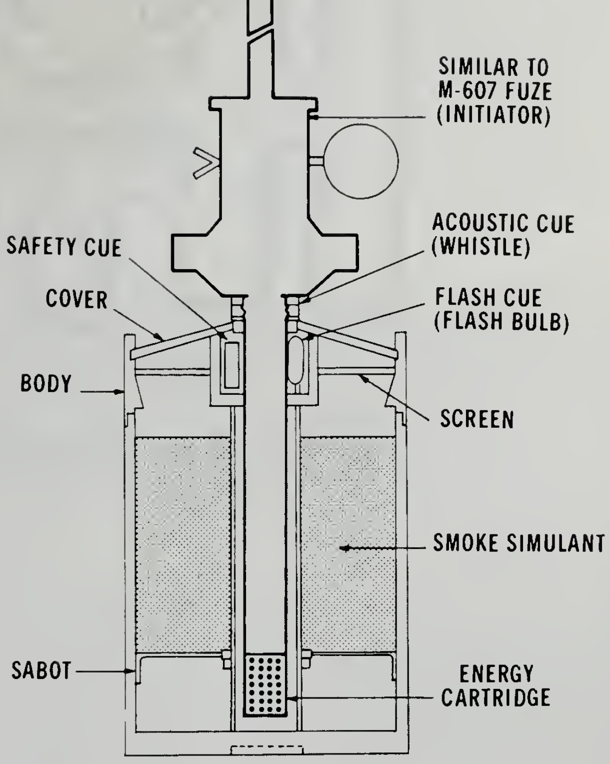


Figure 2.

signal that notifies the tank's MILES that it has been hit.

Different signals distinguish between antipersonnal and antitank mines.

The MILES compatibility of the mine effects simulator permits the scoring of real-time penalties in tactical situations, providing the soldier immediate feedback about the results of his actions. It also helps the unit commander evaluate his success in retaining control of his forces and the effectiveness of his tactics.

The mine effects simulator is designed for safety. It has a whistle which sounds before the simulator fires—allowing soldiers in the danger area to assume a protective posture.

Since Army safety regulations prohibit training systems from approaching the fidelity of actual weapons, the simulator's cues only simulate the effects of mines rather than provide true weapon's fidelity. The smoke cue—a cloud formed from inert powder—is expelled from the device by the detonation of the black powder energy cartridge beneath a sabot.

The mine effects simulator is housed in a cylinder the dimensions of an M16AP mine. It is similar to the M16AP and the M15AT mines in physical appearance and weight and provides the same actuating options—pressure, trip-wire and tilt rod—as actual mines.

The simulator will consist of three components:

- A body resembling either the M15AT or M16AP mine.
- An initiator resembling either the M607 or M605 fuse.
- An energy cartridge containing black powder.

Units will draw the body and initiator from their training aids support center. The energy cartridge will be classified as ammunition and will be handled and distributed through the ammunition supply points. This will reduce the unit's ammunition expenses.

The mine effects simulator will provide the Army realism and responsiveness for effective mine warfare training.

Dianna K. Green is chief of the Training Support Branch, New Equipment Systems Office, Directorate of Training and Doctrine, at the Engineer School. She has a bachelor's degree in chemistry and a master's degree in environmental sciences.

HIT!
Target destroyed!

A way to ensure first-round hits!

Range Finder for CEVs

by CPT Paul Harwig

When the tank commander gives the combat engineer vehicle crew a fire command, there is no margin for error—even in training. Wasted rounds cost $400 a shot. Yet, estimating range is typically a problem because laser range finders are not standard equipment on the CEV.

The most accurate alternatives—taping or pacing off the distance—take time, forcing the tank commander to choose between accuracy and speed. Without an accurate range determination, the first round is usually a miss. The crew must use the burst on target (BOT) method of adjusting fire. It may take several shots to hit the target.

To save ammunition, the 42nd Engineer Company, Berlin Brigade, improvised a rapid range finding technique using a MIL formula for the Hewlett Packard (HP) 41C programmable calculator. The company tested the program during gunnery training at the Bergen-Hohne NATO Training Area, Germany, in March and October 1985. The CEV section chief, SSG Patrick Keener, successfully used the hand-held engineer calculator to compute the range. His crew made first-round hits every time they fired.

A short routine (Figure 1) simplifies the process of solving the MIL formula for range. The HP41C prompts the user, asking the target size (in meters) and how many MILs the target fills in the sight reticle. It returns the range in meters or tells the tank commander the target is out of range. The tank commander relays the range to the gunner during the fire command. The gunner lays his sights on the target at that range.

For wartime planning, engineer companies normally calculate distances to targets from preplanned firing points and list the range in the tank commander's target folder. However, the preplanned firing point may prove unusable when the CEV gets to the site. The tank commander must choose a new firing point and determine the range. That's when the MIL formula program proves its worth.

For example, if he is firing at a bridge abutment, the tank commander selects a bridge dimension from the sketch in his target folder. He runs the MIL formula program on the engineer calculator, inputting the size and number of MILs in the main gun site reticle. The HP41C quickly determines the range.

A similar process works for targets of opportunity. For example, the CEV is told to destroy a bunker at an unknown range. The tank commander knows the bunker doors are generally 2 meters tall. His gunner sets the CEV sight on the door and reads that the height is 2.5 MILs. The tank commander runs the program, inputting the size and MILs. The calculator tells him the range is 800 meters. He calls the range in his fire command to the gunner who lays the sight on the target at 800 meters and achieves a first-round hit.

The company ordered the HP41C as a nonexpendable item for $163.83, and it arrived within a month. With main gun rounds costing more than

Figure 1.

MIL Formula

```
01◆LB "RANGE"
02 FIX 1
03 "SIZE?="
04 PROMPT
05 "MILS?="
06 PROMPT
07 /
08 1000
09  *
10 900
11 X<Y?
12 GTO 01
13 CLA
14 ARCL Y
15 " ⊢METERS"
16 PROMPT
17◆LBL 01
18 "OUT OF RANGE"
19 PROMPT
20 END
```

$400 a shot, the calculator paid for itself the first time the company fired a round. The computer is listed in the Army master data file (AMDF) as a calculating machine, NSN 7420-01127-0451. It falls under GSA contract GS-00F-69222. CTA 50-909 is cited in the justification.

The HP41C has a number of minicomputer capabilities designed specifically for combat engineers. The Construction Engineer Research Laboratory developed a read-only-memory (ROM) module that plugs into the back of the HP41C. The ROM consists of six programs plus subroutines covering bridge classification, critical path method, road crater, demolition, mine, and wire calculations. (An article describing the ROM appeared in *ENGINEER*, Fall 1982.) The ROM chip is available through CERL, ATTN: CERL-FS, John Deponai, P.O. Box 4005, Champaign, IL 61820.

CPT Paul Harwig developed the MIL formula program for CEVs while serving as commander of the 42nd Engineer Company (SEP), Berlin Brigade. He also commanded D Company, 54th Engineer Battalion in Wildflecken, Germany. He is currently a student at the Combined Arms Services Staff School at Fort Leavenworth and will pursue a master's degree in geodetic science at Ohio State University. He is a graduate of USMA and EOAC.

Lessons Learned —Survivability

***Editor's Note:* This is the first in a series of combined arms training lessons learned featuring thoughts on tactical issues worthy of reflection and professional debate. It is not a comprehensive discussion, but a collection of impressions, opinions and insights on complex topics. Although these issues are reviewed and compiled by the Directorate of Evaluation and Standardization, the views expressed do not necessarily reflect the doctrine or policy of the Engineer School.**

Issue. Survivability Positions versus Antitank Ditches.

Observations. Task forces increasingly use engineer earthmoving equipment more to construct vehicle fighting positions and less to dig antitank ditches. These positions are basically the same as shown in FM 5-103, except that to survive, a full-turret defilade with a hide position is essential—not just desirable.

Survivability positions are usually given priority over antitank ditches. This is because long antitank ditches cost the defender far more to construct and secure then they cost the attacker to breach. The priority is the task force commander's decision, based on METT-T.

If the commander's priority is survivability, consider using minefields as a less equipment-intensive alternative to antitank ditches. This frees equipment assets to dig survivability positions. Whatever the priority (survivability or countermobility), schedule the use of each piece of heavy equipment by priority and time allowed for each task. Then, adhere to it.

Issue. Survivability Positions that Work.

Observations. Correct positioning allows tanks and TOWs to both survive and kill. Surviving is key—a function of avoiding detection by the enemy and, if detected, moving securely to a different firing position. "What can be seen can be hit . . ." is trite but true.

- The "window" or "keyhole" position is one of the most successful survivability techniques. Simply stated, it limits exposure by deliberately restricting a tank's sector of fire. The tank is exposed only to the targets at which it is firing, then it shifts to other firing positions as targets are destroyed.
- Position to the flank of the enemy and behind frontal cover. It is far easier for an attacker to acquire and kill targets to his front than those to his flank or rear. For example, most kills at NTC are from the enemy's flank.
- Use a full hide position if at all possible. Stay there until the enemy is in the kill zone. A prone or dug-in observer forward gives a much smaller signature than a tank—even a tank in a good firing position.
- Berms need more than 30 to 40 feet of earth to be effective against modern APFSDS rounds . . . clearly impractical. They also make it easier for the attacker to spot the position.
- Hilltops are deathtraps. Use a backdrop and avoid anything that catches the eye. Likewise, a tank positioned in the vicinity of a large boulder or an otherwise prominent terrain feature will almost certainly be detected.
- Use covered routes into and out of firing positions. Experienced crews often put as much priority on covered routes as on the quality of firing positions.
- Valley-floor/open-field positions can be successful. Tank platoons at NTC have taken out battalions using this technique. However, the absence of a covered route of withdrawal is a clear disadvantage. The only way to achieve security is to kill all the enemy within range before moving.

  If used, the position must be well constructed with at least one hull-down firing location for each tank and a covered route to full hide. These positions allow grazing fire analogous to effective machine gun emplacement. Very little of the tank is exposed in the firing location, yet there is normally a wide sector of fire. They can achieve surprise and make it difficult for an enemy element to point out the position to others or accurately adjust indirect fire. The task force often uses this technique with obstacles so that neither the obstacles nor the tanks can be seen until the enemy crests a hill.
- When constructing survivability positions, remember the enemy is almost invariably defeated at close range (less than 1,500 meters) in a web of fire from quality positions. Obstacle systems placed at maximum weapon/sight range prevent the enemy from rapidly assaulting the principal kill zones.

The POC for Lessons Learned is DOES. The Engineer School wants to hear your training experiences—good and bad—so the lessons learned can be shared with the rest of the force. Write: Commandant, USAES, ATTN: ATZA-ES, Stop 271, Fort Belvoir, VA 22060-5271, or call CPT Craig Travani at (703) 664-2172, (AV) 354.

MICROFIX V2.1 automates

by MAJ Todd S. Bacastow, CPT Eugene K. Ressler and MAJ Peter L. Guth

Terrain analysis entered the computer age this summer with the fielding of MICROFIX V2.1 software. All Army terrain teams will receive the new system this summer, and the Defense Mapping School will begin teaching MICROFIX operations in 1987.

MICROFIX V2.1 provides terrain analysts—

- Immediate computer-assisted terrain analysis capability—the first significant improvement in terrain analysis capability since World War II.
- Field experience to help develop more sophisticated systems that will eventually replace MICROFIX.
- Training on a relatively simple system for soldiers who will be primary users of the complex systems under development.

Currently, MICROFIX is the only standard Army system available to support the battlefield commander's topographic needs. It can be used to calculate line of sight profiles; assess placement locations for weapons, radars, or radios; or view three-dimensional representations of terrain.

MICROFIX consists of an Apple II microcomputer with enhancements and peripherals including—

- A hard disc that stores over 20 million characters (20 MB).
- Monochrome and color monitors.
- A dot matrix printer.
- A VCR player.
- A laser disc.

The VCR provides backup copies of the information on the hard disc and loads digital terrain data from prerecorded tapes. The laser disc serves as a map library with up to 50,000 map images on a single disc. The computer displays them on the color monitor and overlays military symbols. All components fit in sturdy olive drab cases that meet TEMPEST certification and field use specifications.

FORSCOM conceived MICROFIX in 1982 as a quick-reaction capability for the XVIII Airborne Corps. They wanted to automate the functions of the intelligence analyst in the G-2 All-Source Production Section.

In 1984, the Belvoir Research, Development and Engineering Center proposed that MICROFIX be tested to define the unique automation needs of topographic units. Terrain units at theater, corps and division level worked with developers to improve MICROFIX and create more hardware and software. The result was the MICROFIX V2.1, which now contains a baseline configuration plus the topographic package.

The baseline software consists of three modules—

- Database application programs.
- Graphics control programs.
- System manager programs.

The database application programs allow the user to define databases and store them on the laser disc. The graphics control programs allow for a common interface with database applications to plot user-defined symbols on the videomaps and to print the overlays on the dot matrix printer. The system manager programs provide a series of user-friendly utilities to copy data and to backup the system on VCR tape.

V2.1 topographic software includes three packages—

- The tactical weather intelligence system (TWI) provided by the Atmospheric Laboratory at White Sands.
- The battlefield environmental effects system (BEES) developed by the Engineer Topographic Laboratories at Fort Belvoir.
- A digital terrain analysis program (TERRANAL) from the Computer Graphics Laboratory at the U.S. Military Academy, West Point.

The TWI package aims to assist the terrain analyst and staff weather officer, but clearly benefits all tactical planners. The five main functions aid in weighing the impacts of terrain and weather on NBC operations, MOPP, smoke operations, aviators' use of night vision goggles, and the effectiveness of the electro-optical target acquisition device.

BEES provides six major functions—historical climatologies for several potential theaters of operations, helicopter density altitude calculations, sunrise and moonrise almanac determinations, cross-country mobility calculations, combat engineering obstacles planning from FM 5-34, and utility conversion routines.

The TERRANAL program provides digital topographic support. The program uses digital terrain elevation data (DTED) Level I produced by the Defense Mapping Agency. Characteristics of the data (resolution 60 to 120 meters; accuracy 30 meters) limit capability. Careful analysis of all results is essential.

Despite limitations, DTED Level I

Terrain Analysis

The MICROFIX system provides topographic analysis for soldiers in the field. The monitor displays terrain features and weather conditions while the printer supplies hard copy to help commanders plan their battlefield maneuvers.

covers most of the northern hemisphere and offers the only digital database that will be widely available for some time. Data sets used by the computer cover 30 minutes of latitude by 30 minutes of longitude, which correspond to four standard 1:50,000 maps or one eighth of a 1:250,000 JOG sheet.

The DTED data retains its geographic coordinate base (latitude and longitude) on the MICROFIX. The computer handles the transformations to and from the UTM coordinates given by the user. The configuration of the MICROFIX hard discs allows up to five data sets to be loaded and accessed simultaneously. The user loads additional data sets from VCR tape.

TERRANAL produces five types of output on the color monitor that can be reproduced on the system's dot matrix printer—

- Line of sight profiles,
- Weapons/sensor masking plots,
- Color-tinted elevation maps (air avenues of approach),
- Slope maps (ground avenues of approach),
- Oblique views.

Images generated using these functions can be stored on the hard disc and recalled to the screen for briefings or further analysis.

MICROFIX is a first generation system that cannot meet all user needs. But it continues to help identify key areas for future development while providing a usable interim system. An ongoing partnership between users and developers will improve MICROFIX further and hasten the day when more advanced systems offer the combined arms commander more sophisticated terrain analysis capability.

The authors integrated the MICROFIX V2.1 system components and developed the digital terrain mapping module for the Computer Graphics Laboratory of the Department of Geography and Computer Science at the U.S. Military Academy.

MAJ Todd S. Bacastow, an assistant professor in the Department of Geography at USMA, is being reassigned in his alternate specialty as a topographic engineer with HQ USAREUR this fall. An infantry officer, he has served as a platoon leader, company commander and staff officer with the Berlin Brigade and the 5th Infantry Division at Fort Polk. He has an M.S. in geography from Penn State and graduated from USMA in 1974.

CPT Eugene K. Ressler is an assistant professor in the Department of Geography and Computer Science at USMA. He served as a platoon leader, company commander and staff officer with the 79th Engineers in Germany. He has an M.S. in computer science from the University of California, Berkeley, and graduated from USMA in 1978.

MAJ Peter L. Guth is a visiting assistant professor at the University of Nevada, Las Vegas, and former assistant professor and research officer in the Department of Geography and Computer Science at USMA. He has served as a platoon leader, company commander and staff officer with the 44th Engineers in Korea and the 34th Engineers at Fort Riley. He has a Ph.D. in geology from MIT, graduated from USMA in 1975 and completed Command and General Staff College.

airfield damage repair

by LTC Gary L. Groat, MAJ John E. Gillette and Dr. Victor C. Barber

Our ability to repair runways quickly may be the single most important factor influencing the next conflict.

Airfield damage is a *war stopper.* The fate of entire military operations depends on our ability to make timely repairs.

Yet, recent training tests by the 416th Engineer Command revealed that much of the TOE equipment available to combat heavy engineer battalions is not ideally suited for runway repair.

This costs precious time and hurts quality, especially if units are unfamiliar with repair techniques.

Emergency repair is complicated by the fact the Army and Air Force share responsibility. Army equipment differs both within the Army family (active and reserve component) and from that available to the Air Force.

Ultimately, these differences may make it necessary to modify existing procedures, techniques and doctrine.

The regulations say the Army *assists* with emergency repairs when the damage exceeds the capability of the Air Force and makes all beyond emergency (semipermanent) repairs.

The fact is runway repair has now become a primary combat heavy battalion mission.

As air superiority grows more vital and runways become more vulnerable to new, more destructive bombs, the Army anticipates increased reliance upon the combat heavy to keep runways operational during the initial stages of any conflict.

Yet, OCONUS units—both Army and Air Force—have been slimmed down. Engineer assets are in short supply and high demand.

Since our ability to repair runways quickly may be the single most important factor influencing the next conflict, the challenge is threefold:

- To practice crater repair techniques as an integral part of any unit training program so soldiers are skilled in the application of techniques and familiar with the capabilities of their equipment, avoiding pitfalls that waste time.
- To evaluate the appropriateness of the TOE for major mission tasks and seek better crater repair equipment.
- To take the initiative in encouraging the joint Army/Air Force training essential to effectively accomplish this mission in wartime. A memorandum of agreement (April 5, 1985) between the services provides for coordination and encourages coordinated development, fielding and employment of runway repair systems.

We must also remember that runway repair goes beyond filling craters. Units should change their overall mission statement to stress "restoration of the runway or facility"—not just "repair of a crater."

Field Tests

The 416th Engineer Command—which provides civil engineering planning support for U.S. Central Command—recognized the need to expand airfield damage repair training.

Evaluation of the engineering requirements for a variety of Southwest Asia scenarios made it apparent that airfield damage repair would be a key engineering mission during the early stages of any conflict. However, most engineer troops have only textbook knowledge of repair techniques.

During the summers of 1984 and 1985, the 961st Engineer Battalion tested platoon-sized units on four runway repair techniques.

Two were emergency:

- Crushed stone with foreign object damage (FOD) cover.
- Sand grid method.

Two were beyond emergency:

- Stone grout method.
- Concrete cap method.

With research of new crater repair techniques, materials and equipment underway at both Army and Air Force labs, a field training program was developed for the 961st and 389th Engineer Battalions in cooperation with the Waterways Experiment Station and the Engineer School. The objectives were to—

- Familiarize unit personnel with bomb damage repair procedures.
- Test the appropriateness of the organic TOE equipment found in a typical combat heavy engineer battalion.
- Suggest improvements.

To restore a minimum operating strip approximately 50 x 5,000 feet, combat heavy engineer units must anticipate repairing up to 20 large craters (>20 feet in diameter), 30 to 50 medium craters (<20 feet in diameter), plus thousands of spalls throughout the work area. Repairs may have to be made in an NBC environment on a field littered with unexploded ordnance and antipersonnel bomblets.

For realism, the 389th Engineer Battalion paved an unsurfaced runway to specifications typical of Southwest Asia. Then, runway demolition teams from the 961st cratered the surface to simulate damage from a 750-pound bomb.

Four 20-foot-diameter craters plus the resultant 2 to 3 feet of debris provided a realistic training site. A 750-pound bomb crater displaces about 400 cubic yards of debris. Even when all the debris is backfilled into the crater, nearly 150 cubic yards of additional fill is required to repair a typical crater.

During the training, the 961st made seven tests using the different emergency and beyond emergency techniques. Repairs took considerably longer than anticipated.

NATO STANAG 2929 sets a goal that emergency repairs—those immediately required to allow air missions with minimum risk to aircraft—be conducted within 4 hours.

The Army and Air Force have incorporated this into doctrine, but it remains a goal that has proved difficult to meet.

It includes the time required to assess damage, remove unexploded ordnance, calculate the best place to make repairs, and haul equipment to the site.

During the Air Force exercise SALTY DEMO, the average time was 1.5 hours for site reconnaissance and MOS selection; 5 for on-site repair work.

Beyond emergency work—semipermanent restoration to nearly original condition—is far more time consuming.

The actual time allotted is classified, but well within the capability of a unit like the 961st. The challenge, however, is to produce a quality product with the equipment in the current TOE. The 961st experienced critical shortfalls in standards of compaction and quality of the grout mixture.

Lessons learned focused on—

- Problems with TOE equipment.
- Non-TOE equipment that could expedite repairs.
- Construction tips that save time and improve quality.

TOE Equipment

The limitations of TOE equipment made it difficult to make quality repairs expeditiously. Compaction equipment was inadequate—either too small or too large for the job. This is the most critical problem facing the active and reserve units responsible for airfield damage repair.

The vibratory roller lacked mobility and maneuverability. It was difficult to get in and out of the crater and tended to crack undamaged runway edges.

It was too large for early compaction runs and could only be used for final passes within 8 inches of the surface.

A vibratory roller is critical when making semipermanent repairs where the entire crater must meet lift compaction requirements of 95% CE55 for the first 8- to 12-inch lift and 100% CE55 for the final 8- to 12-inch lift.

Gas-operated hand compactors, although easy to handle and maneuver into and out of the crater, did not compact backfilled debris to the required depth. They were extremely slow and exposed personnel to unexploded ordnance hazards.

The 250-CFM air compressor jack hammer used for cutting runway uplift was too slow, too small and too dangerous—exposing personnel to unexploded ordnance.

The JD410 backhoe was one of the most useful tools in the test—extremely good for backfilling and material handling. But the bucket reach was too short for a 20-foot crater. A longer reach would save time—about 25%—spent jockeying the JD410 into position.

Pavement drilling equipment was too slow for the quantity of bolt holes required. The electric pioneer trailer was the only tool available to drill the required ⅝-inch diameter holes.

The low bed trailer was indispensable for moving cement bags to the mix sites.

The 6,000-gallon water distributor tank unit was ideal for concrete and grout mixing sites.

Front-end loaders, dump trucks, and D7 and D8 dozers were important parts of the operation.

Non-TOE Equipment

Two items of non-TOE equipment were used with mixed results.

A gasoline operated pavement breaker, which is currently being purchased for USAF Red Horse (engineer) battalions, was on loan from Fort Belvoir.

This equipment performs the same functions as the 350-CFM air compressor.

The most useful attachment is a 1½-inch concrete drill that drills eight holes, 1-inch deep, in less than a minute. The concrete cutter and soil spade tools were much more portable than those on the 350-CFM.

A heavy duty electric impact drill for drilling bolt holes in runways was provided by the Corps of Engineers Waterways Experiment Station. The multirotary hammer (Model TE22) is commercially available. It drills ⅝-inch-diameter holes, 8 inches deep, in 1 minute or less.

Construction Tips

A number of opportunities to improve construction methods were identified:

Crater Lip Removal—The D7 and backhoe are the fastest ways to remove uplifted concrete. The concrete breaker on the 350-CFM compressor was extremely slow.

Compaction and Backfill—The most time-consuming task is soil compaction.

By improving efficiency here, the entire construction schedule could be shortened.

Unless larger equipment becomes available (and the crater allows room to maneuver), the soil must be compacted in many small lifts with the hand compactor to assure correct compaction.

The nuclear density tester is indispensable to rapidly verify compaction. Considerable emphasis must be placed on the need to obtain proper compaction as well as the methods of achieving it.

Final Subbase Lift (Sand Grid)—The crater must be filled to within 16 to 22 inches of the surface before

Testing in a realistic environment reveals the combat heavy TOE is inadequate for rapid airfield damage repair. Here, engineers from the 961st combat heavy place cement. The TOE modifications being considered by the Directorate of Combat Developments would overcome current problems with quality, equipment, and time.

inserting two levels of sand grids. Anything shallower produces a lift in the finished surface. Extra sand can be used to level the surface if the debris/fill is deeper than 16 inches. Don't exceed 2 inches above or below any layer of plastic grid.

Open the grids at waist level so they are fully extended, then set them in place. While extended, fill a few grids by hand to anchor the material. Fill the remaining grids with the bucket loader or backhoe. Don't stake grids in the ground at one end and then attempt to extend them. It takes more time and equipment. A chain saw is very useful for cutting sand grid material to size before expansion.

Final Subbase Lift (Well-Graded Gravel)—The top layer of gravel (fiberglass matting technique) takes much longer than sand grid. Unless it is perfectly level, dips and humps develop in the runway.

When using the vibratory roller to compact the top layers, be careful not to compound the damage by breaking off the edge of the adjacent runway. Don't make turns on the patch. To be even with the runway surface after compaction, the crater shouldn't be filled more than an inch or two above the grade.

Final Runway Surface (Slurry Cement Mix)—When concrete is mixed using the 16S mixer, a JD410 tractor and wheelbarrows are required. Cover the area around the mixer to channel the liquid into the crater and to aid in a speedy cleanup of adjacent runway areas.

Placing the calcium chloride over the grout in the crater makes it difficult to get a good mixture. This material should be added in the final third of the cement batch. Approximately 2 hours remain to add stone and obtain a finished grade after adding the calcium chloride.

Use a very heavy plastic (10 mils or thicker) to cover the backfill so sharp stones don't puncture the seal. Sheets 12 to 15 feet wide should be considered the minimum. The seams between plastic sheets must be sealed with waterproof tape. Military issue 3-inch duct tape works well.

It helps to slide the slurry into the crater on a sheet of plywood. Dumping the mix into the hole is hard on the plastic seal and breaks down the mix. Don't use the vibrator. It gets stuck easily. A screed beam placed from edge to edge of the crater helps keep a level surface.

Matting—The bolts on the matting broke loose and couldn't be removed or tightened. The Waterways Experiment Station is working to correct this problem.

The slow drilling problem was resolved by using larger (1½-inch) bolts. The larger holes provide greater tolerance, permitting the holes to be drilled before the mat was towed into place. A calcium chloride cement grout was used to anchor the bolts. Epoxy was not available for the test.

Loose nuts and other parts were easily lost or separated from the matting. These items should be identified early and stored until needed. Having extra bolts and bolt cutting equipment on site would expedite the repair construction schedule.

Conclusion

Runways are tactical, logistical and mobility lifelines—primary targets for the enemy's attempt to cripple his opponent. To counter this threat, engineers must be able to complete quality repairs in the shortest possible time.

The combat heavy battalion's airfield damage repair capability is an issue of ongoing interest at the Engineer School.

Army Field Circular 5-104-1, *Airfield Damage Repair*, October 1985, provides further guidance on approved techniques.

The Directorate of Combat Developments is considering TOE modifications—reviewing prototype tools like an interchangeable drum compactor and a pavement breaker attachment for the Small Equipment Excavator (SEE)—that hold promise for improved efficiency and capability.

Meanwhile, units must learn the Army's bomb-damage repair procedures and work with their Air Force counterparts to encourage efficient use of available resources.

LTC Gary L. Groat is a staff officer with HQ, 416th Engineer Command (USAR), Chicago, IL. He served in the Construction Directorate, Military Assistance Command Vietnam, and was a company commander with the 24th Engineer Battalion in Germany.

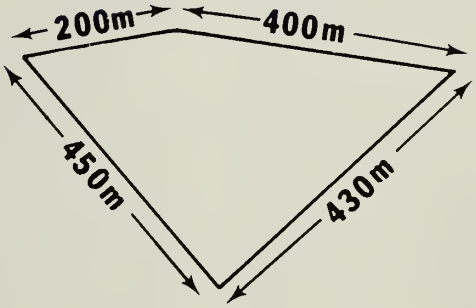
He is vice president of DeLeuw, Cather and Company, a consulting engineer firm specializing in transportation engineering. He has a bachelor's degree in architecture from the University of Illinois, a master's degree in science from the University of Wisconsin, and is a graduate of CGSC.

MAJ John E. Gillette is XO and manager of the airfield damage repair work for the 961st Engineer Battalion (CBT)(HVY), Milwaukee, WI. He has managed water-system construction in the Philippines for the 1st Civil Affairs Battalion, Okinawa, and was the S-3 for the 36th Engineer Group (CBT) in Korea. He was also commander of the 517th Detachment (Terrain) in Germany.

Dr. Victor C. Barber is a research civil engineer at the U.S. Army Corps of Engineers Waterways Experiment Station. He specializes in military pavements and mine and countermine research and development.

Engineer Problem

Your platoon supports the 1/52nd Infantry Battalion located in the base camp shown below.



You are tasked to construct—

- Three 81mm mortar emplacements
- Two 4.2-inch mortar emplacements
- A protective wire fence around the camp limited to one of the following:
  - A. Two belts of 4- and 2-pace double apron wire
  - B. Triple standard concertina
  - C. A combination fence with one belt of each type

You have the following assets—

- 32 D-handle shovels
- 2,000 U-shaped long pickets
- 2,000 U-shaped short pickets
- 180 reels of barbed wire
- 700 rolls of concertina
- Unlimited corrugated metal

Your work is to be done at night, and your platoon is experienced in this work. Time is a critical factor.

Step 1. What type of fence will you construct and why?

Step 2. How many man-hours are required to complete all tasks?

REFERENCE: FM 5-34, Engineer Field Data

Problem/Solution submitted by CPT Craig Wonsidler and SFC Wayne A. Baker, EOBC Training Detachment, Department of Combined Arms.

AIRLIFT BRIDGE TRAINING LESSONS

by LTC Daniel Waldo

Training for engineer assault float bridge companies under wartime conditions is essential, but all too rare. ARTEP 5-64, Task 10-20, calls for helicopters as an integral part of ribbon bridge operations. V Corps in Germany successfully made combined arms airlift bridging a monthly FTX for ribbon bridge units.

Regular exercises allowed the 549th Engineer Battalion to identify typical problems and develop a systematic approach to bridging operations. The benefits for engineers and Chinook pilots were tremendous.

Initially, Chinook 47 aircraft availability was a problem. But as airflift bridging FTXs became a regular part of the monthly training schedule, the Chinook pilots' enthusiasm and interest grew.

In the first exercises only the bays were airlifted, but bridge boats were soon included. Bays and boats were offloaded from transporters in an open field where aircraft systematically picked them up and flew them to the river. But this proved unrealistic because it would leave all equipment exposed to hostile activity. Ideally, only one piece of equipment at a time should be exposed and for the shortest possible time.

The engineers decided in coordination with pilots and crew chiefs to lift the bays and boats directly off transporters. The transporters—carrying bays and boats rigged for airlift—remained concealed until the last minute, pulling out into the pickup area as the helicopters arrived.

Before airlift, the bay latch pin was inserted into the travel latch and the lanyard rigged up in the bay. When the bay was set in the water, the crew approached the bay and pulled the lanyard, releasing the pin and unfolding the bay. Correct procedures had to be used or the crew lost time using boat hooks to release the travel latches.

The raft commander was responsible for organizing his loads in the sequence he wanted them lifted—boats first, interior bays, then end bays. This was easy for the pilots who automatically lifted whichever load pulled into the pickup area.

Peacetime safety requirements precluded allowing engineer divers to airdrop or rappel into the river to do their reconnaissance and recover the first boat. This lift was simulated, and a safety boat carrying the first crew was launched from the shore. After the first airlifted boat was recovered, the other crews were airlifted to the friendly near shore.

Boat crews recovered airlifted boats, which are first in the lift sequence. The remaining crew recovered the bays and began raft construction.

Repeated FTXs provided unexpected insights. Believe it or not, most pilots have no idea which direction is upstream or downstream. It proved important for engineers to discuss with pilots where the rafts were to be set down. With raft construction ongoing at the crossing site center line, drops should be made slightly downstream of the center line. This avoids interference with rafts under construction if problems occur.

It helped the pilots when one boat was conspicuously marked so they could spot it quickly and always set the load upstream of the boat. Visual cues and signals proved particularly important when operating under radio silence or when communications equipment failed.

Pilots had a tendency to take off at an angle once they released their load. The propeller blast caused the bays to move and slowed down retrieval and construction operations. Pilots needed to be told to lift directly up, then maneuver away.

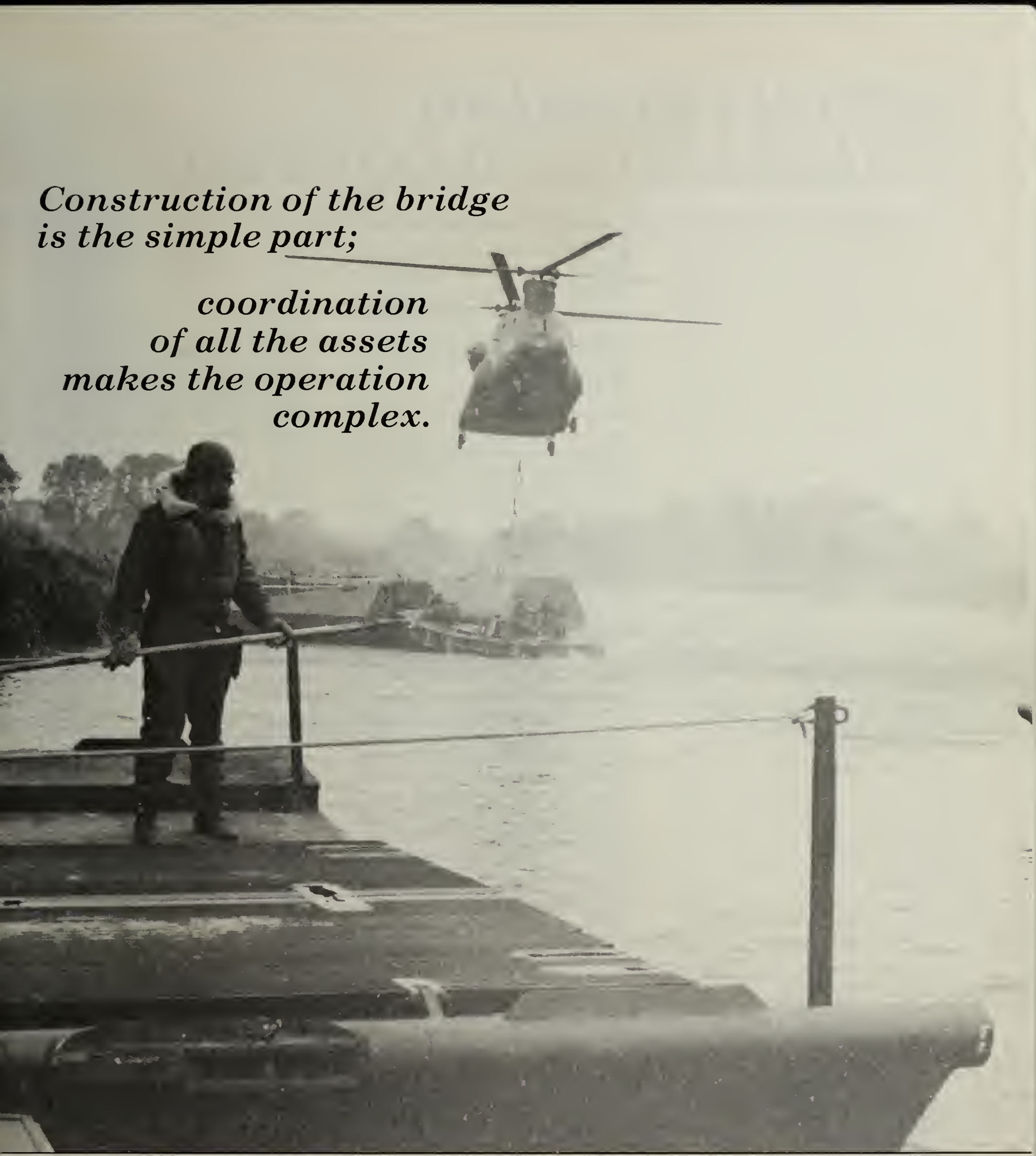
This left the bay sitting still and easy for the crew to approach and retrieve. On a river like the Rhine where the current moves at 6 to 8 feet per second, it is extremely important how and where the crew sets down.

Boat cabs were not airlifted or used because they restricted movement. In winter, water froze on the windshields blocking vision. Needless to say, boat crews found wet weather gear essential during retrieval operations.

Airlift bridging provides excellent combined arms training for engineers and aviators in V Corps. The techniques are as realistic as peacetime safety constraints allow. The

Construction of the bridge is the simple part;

coordination of all the assets makes the operation complex.



only deviation from wartime practice involves launching the safety boat with the first boat crew. The 549th Engineer Battalion deactivated in January 1986; however, airlift bridging remains an important monthly exercise for V Corps' ribbon bridge units and Chinook crews.

LTC Daniel Waldo is the deputy commander for military programs at the Corps of Engineers, Los Angeles District. He commanded the 549th Engineer Battalion in Schwetzingen, Germany, and was XO for the 565th Engineer Battalion in Karlsruhe, Germany. He has also served as the DEH in Garmisch, Germany, and on the staff of the HQ USAREUR ODCSOPS. He is a graduate of USMA and CGSC. He has M.S. degrees in civil engineering from the University of Illinois and in international relations from Troy State. He is a registered professional engineer in Virginia.

RIVER CROSSING COMMAND AND CONTROL

by LTC Daniel Waldo

Effective river crossing command and control requires accurate, timely status reports on crossing traffic. However, the communications assets available to track complex crossing operations are meager.

When five bridge companies are calling the TOC from five crossing sites, it's essential that they communicate quickly. Before deactivation in January 1986, the 549th Engineer Battalion in Schwetzingen, Germany, developed an alpha code reporting system that proved quick and effective in three FTXs and became standing operating procedure for V Corps.

To move forward in the V Corps' area of operations, most of the 8th Infantry Division and follow on forces cross the Main River. The 549th Engineer Battalion's primary mission in the corps' general defense plan was the command and control of river crossing operations. All the corps' float bridge units—541st Engineer Company (MAB), 8591st Civilian Support Group (RB), 814th Engineer Company (RB)—and both divisional bridging units—E/12 (RB) and E/23 (RB)—were attached to the 549th.

At the 549th, a 35-soldier HHD with only limited radio assets handled this complex command and control mission. During ARTEPs and FTXs, the bridge companies verified their ability to raft, bridge, and cross maneuver units. However, the HHD's ability to sustain 24-hour operations was always questioned. A cumbersome, line item reporting system had to be revised to improve efficiency.

Using the 549th's procedure, an alpha code is applied to each crossing condition (Figure 1). The bridge units are given their basic mission—to have a raft or bridge operational at a particular crossing site at a specified time. The code becomes the basis for reporting. By adding codes, the system can be tailored for different needs. For wartime security, the code would change daily.

As alpha codes are reported, each unit's activities are tracked on a large board at the TOC. The crossing force commander and crossing area engineer can tell at a glance:

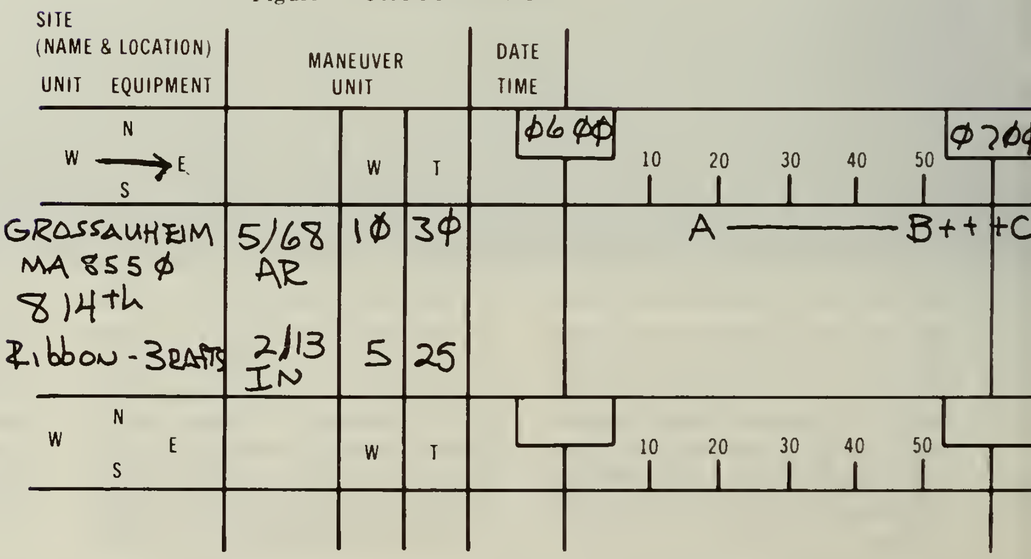
- What units have crossed, where, when, and with what.
- What units are currently crossing.
- What unit is in the engineer

Figure 1.

Alpha Code and Tracking Symbols

Alpha = Equipment departs bivouac site; bridge closure begins.
Bravo = Equipment on site and operational.
Charlie = Traffic at ERP (unit ID; number of wheels and tracks).
Delta = Begin crossing.
Echo = End crossing.
Foxtrot = Equipment returns to bivouac area; break bridge.
— — — Water march; moving to new site on the river.
+ + + Maintenance and resupply at the river; not crossing.
• • • • Crossing traffic.
——— Other.

Figure 2. CROSSING PLAN



SITE (NAME & LOCATION)
UNIT EQUIPMENT
MANEUVER UNIT
DATE TIME

N
W → E
S
W T
0600
10 20 30 40 50
070

GROSSAUHEIM
MA 8550
814th
Ribbon - 3 RAFTS
5/68 AR
2/13 IN
10 30
5 25
A ———— B + + +C

N
W E
S
W T
10 20 30 40 50

regulating point (ERP) or en route from the ERP to the crossing site.

- The status of bridging units, location and current activity.

Here is how the alpha code works.

The 814th Engineer Company receives the mission to have rafts operational at the Grossauheim site NLT 0700. Activity by the 814th is shown in Figure 2. When the unit moves from its bivouac site at 0620, the battalion TOC receives the simple message: "*Alpha* 0620." At 0650, the message "*Bravo* 0650" tells the TOC that all equipment is on site and operational.

These brief radio contacts quickly provide the exact status of the unit. When the 814th calls "*Charlie*" at 0705, it uses the unit identifier codes in the CEOI to inform the TOC that the 5/68 Armor is at the ERP with 30 tracks and 10 wheels.

Following normal river crossing procedures, the ERP will release raft loads in the priority requested by the maneuver commander. When the first raft load reaches the river and starts crossing, the unit reports, "*Delta* 0830."

While units are crossing traffic, they report status every hour on the hour. When the 814th reports, "0800; 20 *Tangos*, 3 *Whiskies*," the TOC understands that, as of 0800, 20 tracks and 3 wheels have crossed, even if radio contact is made late—at 0810 for example.

When crossing is complete, the 814th confirms that all traffic originally reported in the ERP has crossed, stating: "*Echo* 0830; 30 *Tangos*, 10 *Whiskies*."

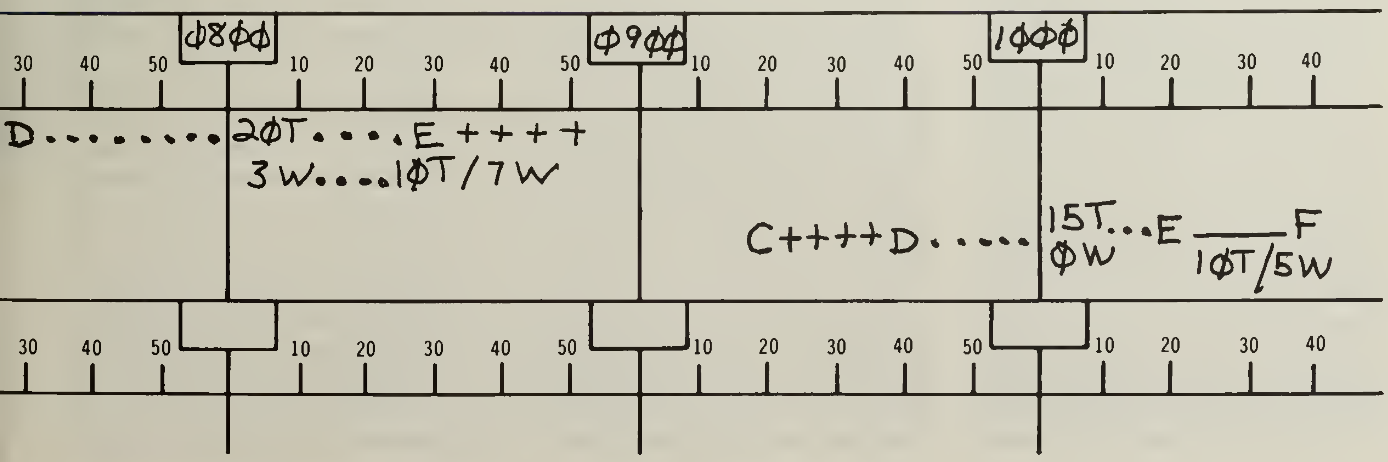
The unit then goes into a maintenance mode awaiting further missions. When the 2/13 Infantry arrives at 0915, the 814th reports: "*Charlie* 0915." They give the CEOI identifier code for the 2/13 and the status: "25 *Tangos*, 5 *Whiskies*."

When the 2/13 finishes crossing, the 814th is told to return to the bivouac site. Back at bivouac, the unit reports "*Foxtrot* 1040."

If enemy activity had compelled the 814th to relocate to a new crossing site at 0930 before the 2/13 finished crossing, the unit would have called in "*Echo* 0930; relocating." At 1000, the unit would give its routine hourly report to update the TOC on the number of vehicles that crossed before the interruption. When crossing resumes at a new location, the 814th uses appropriate codes within the CEOI to give the new grid coordinates of the new crossing site so the traffic control points can reroute traffic.

The use of abbreviated code systems isn't new to the Army. This simple system was developed to communicate important river crossing information. Engineer units can easily adapt and modify the code for their own use.

LTC Daniel Waldo is the deputy commander for military programs at the Corps of Engineers, Los Angeles District. He commanded the 549th Engineer Battalion in Schwetzingen, Germany, and was XO for the 565th Engineer Battalion, Karlsruhe, Germany. He has also served as the DEH in Garmisch, Germany, and on the staff of the HQ USAREUR ODCSOPS. He is a graduate of USMA and CGSC. He has M.S. degrees in civil engineering from the University of Illinois and in international relations from Troy State. He is a registered professional engineer in Virginia.



Combined Arms Water Obstacle Training Sites

BY LTC Floyd Elton Byrd

Tactical scenarios that require crossing the Arkansas River will soon enhance combined arms river crossing training. The Engineer School is developing scenarios and operation orders for brigade, task force, and company teams that can be adapted for mechanized infantry heavy or armor heavy units. They will be available to Active Army, National Guard and Army Reserve maneuver units.

Ongoing improvements to the combined arms water obstacle training site (CAWOTS) at Fort Chaffee, AR, are under way. Three crossing sites are complete and another is under development. The extensive road network is being upgraded. Equipment parks and assembly and launch sites are also planned.

The old family of bridging (Bailey, M4T6 and CL60) will be stored and maintained at the CAWOTS site so they are readily available. A Bailey bridge and a timber trestle bridge kit are there now. The M4T6 and CL60 will be delivered when funds are available.

Fort Chaffee—a subpost of Fort Sill, OK—was identified as a combined arms water obstacle training site in 1985. A recent search of 50 other potential CAWOTS locations verified that Fort Chaffee is the best site available for combined arms training.

Good technical and tactical fast water obstacle training is offered on the military reservation and adjoining Corps of Engineers' property. Other advantages include: Fort Chaffee's central location, access to major road and rail networks, and an extensive range and training area.

The Arkansas River is located about 2.5 kilometers north of the Fort Chaffee military cantonment area. There are numerous crossing sites along a 5-kilometer stretch of river just below Lock and Dam 13. Analysis of the flow data indicates the training site would be usable 88% of the time based on river access at a 116-meter surface elevation.

Even at flood stage the average current is 2.5 meters per second (MPS). During low water or drought, sufficient flow can be maintained to allow realistic, challenging bridging and rafting operations. The flow can be modified for short periods by the lockmaster at Lock and Dam 13. The lockmaster can also provide flow data and predictions.

The actual stream varies from 183 to 275 meters wide and 2.5 to 4.25 meters deep. Velocity varies from 1 to 2.5 MPS. The navigation channel is 75 meters wide and 3.75 meters deep.

The maneuver area on the south bank is 2.5 kilometers deep and 5 kilometers wide. The north bank maneuver area is 1 to 2.5 kilometers deep and 2.5 kilometers wide. The maneuver room north of the Arkansas River precludes brigade-

Engineers position a bridge section at one of Fort Chaffee's four training sites on the Arkansas River.

Working against swift current, Arkansas National Guardsmen complete this 800-foot bridge in 36 minutes.

size combined arms river crossings; however, smaller combined arms crossings can be conducted.

Access to both banks is through scrub timber, undergrowth and alluvial sand. Bank conditions on both the north and south shores permit numerous access points. Both sides are well-drained, with the north bank somewhat higher.

Water Obstacle Training Sites

Installation	Width	Minimum Depth	Velocity Per Second	Maneuver Space	
				1st Shore	2nd Shore
Ft Drum NY					
Black River	122m	10m	1-2.5m	10x15km	1x2km
Indian River	46m	1m	1.5m	10x15km	3x8km
Ft A. P. Hill VA					
Lonesome Gulch Lake	122m	3m	0	6x10km	3x2km
Camp Shelby MS					
Lake Janney	135m	2m	0	5x8km	3x7km
Ft Chaffee AR					
Arkansas River	183m	6m	2.5m	2.5x5km	1.5x2.5km
Engineer Lake	152m	3m	0	4x7km	2x2km
CP Ripley MN					
Mississippi River	135m	3m	1-2.5m	6x8km	Drive thru only
Miller Lake	183m	3m	0	3x5km	3x2km

Regional Water Obstacle Training Sites

Four regional water obstacle training sites have also been designated. They are: Fort Drum, NY; Fort A.P. Hill, VA; Camp Ripley, MN; and Camp Shelby, MI. They offer some combined arms potential, but primarily provide active and reserve component engineers:

- The non-TOE equipment necessary to practice wartime and ARTEP bridging tasks.
- Adequate water obstacle training sites at or near home stations.

The chart summarizes the physical characteristics for each of the sites. Units wishing to take advantage of CAWOTS or regional sites should contact the following site coordinators.

Commander
Fort A. P. Hill
ATTN: ATZM-FHI (Mr. Wells)
Building T143
Bowling Green, VA 22427-5000
AV 934-8204
AC (804) 633-8204

Commander
USAG Fort Chaffee
ATTN: ATZR-ZFE (CPT Muehlberg)
Fort Chaffee, AR 72905-5000
AV 962-2777
AC (501) 484-2777

The Adjutant General
Mississippi Army National Guard
ATTN: MSNG-POTO (COL Traxler)
PO Box 5027
Jackson, MS 39216-1027
AV 637-6311
AC (601) 949-6311

The Adjutant General
Minnesota Army National Guard
ATTN: MNAG-POTO (COL Forslund)
Veterans Service Building
St. Paul, MN 55155-2098
AV 825-4675
AC (612) 296-4675

Commander
10th Mountain Division
ATTN: AFZS-PTS-PO-O (Mr. Shaughnessy)
Fort Drum, NY 13602-5000
AV 341-6896
AC (315) 785-6896

LTC Floyd Elton Byrd is the training development coordinator at the Engineer School. He served previously as the TRADOC master trainer for the Leadership Assessment Program at First ROTC Region, Fort Bragg, NC, and as battalion commander of the 527th Engineer Battalion (CBT)(HVY).

THE TASK FORCE ENGINEER IN THE DEFENSE

by CPT Gregory R. Wine

The brigade's counterattack—delivered by an armor heavy task force with an attack helicopter troop and close air support—has destroyed the enemy's first-echelon motorized rifle division. Intelligence reports indicate that successful interdiction missions have delayed the second-echelon motorized rifle division for 36 hours.

You are a recent EOBC graduate assigned as a combat engineer platoon leader. Your platoon directly supports the armored task force whose mission is to defend in sector and destroy the lead motorized rifle regiment. As the task force engineer, how do you contribute to the success of the mission?

First, act the part of a task force staff officer. You must—

- Be ready to advise the task force comander and S-3 at all times. This requires constant radio contact with the task force command net.
- Speak the language of the task force. In other words, know the task force's tactical standing operating procedures (TACSOP). You can reduce radio transmission time.
- Maintain communications to keep higher engineer headquarters up-to-date and to pass along required reports.
- Use a net other than the task force command net to maintain contact with the rest of the platoon.
- Coordinate with other staff members and company team commanders.
- Assist the task force S-3 in writing the engineer annex to the task force operations order.

Communicate with the platoon sergeant. He, too, must fully understand the task force commander's intent and scheme of maneuver. The platoon sergeant is out in the dirt and the dark making things happen—supervising, coordinating, and reporting as obstacles are emplaced.

Anticipate. Things start moving when brigade sends the FRAGO to defend. A good engineer company commander will already be on top of the situation, planning to get the necessary engineer equipment forward.

Start by understanding the mission and assessing engineer capabilities for the task force commander's METT-T analysis. Get with the task force S-4 and request logistical support (Class IV and V). Don't wait for a hard copy OPORD; use your initiative to start work immediately.

Understand the scheme of maneuver. As soon as the task force commander completes his mission analysis, he begins planning his scheme of maneuver. You must participate in the entire planning process to advise the task force commander on an obstacle plan which supports his scheme of maneuver. First, you must understand how and where he plans to destroy the enemy.

Enemy avenues of approach. You and the task force S-2 should give the task force commander an analysis of the enemy avenues of approach. You must be an expert in analyzing terrain—able to identify mobility corridors and avenues of approach required by company-sized threat units.

The S-2 may be responsible for intelligence and reconnaissance missions—using a reconnaissance/surveillance plan to control the scouts and the ground surveillance radar. Ask him for the valuable information not available from a map reconnaissance. Then, determine possible locations for obstacles. Inform the commander of those which support his intent.

Tentative battle positions. The task force commander will select tentative battle positions keyed on weapon systems, planning ranges and engagement areas. Obstacles are extremely effective in engagement areas, so plan accordingly.

Mobility for company teams. You must ensure planned obstacles don't limit the mobility of the task force.

Lanes or gaps may be required to maintain mobility between battle positions.

Task-organization. When task organizing your company teams—a key step in obstacle planning—you must know the locations of the weapon systems.

Develop an obstacle plan. To begin, you must know the—

- Locations of all battle positions including the type of weapon systems in each.
- Withdrawal routes to the battle positions.
- Required lanes or gaps within the task force engagement areas.
- Counterattack routes.
- Trigger and break points for each battle position.

Focus on major avenues of approach. Reinforce terrain with existing obstacles. Don't forget to include obstacles directed by higher headquarters. Analyze each battle position, keying on the weapon systems located there. Plan obstacles to enhance the effectiveness of weapon systems at trigger and break points.

Trigger points—identified by target reference points—indicate where initial enemy engagement will take place. Obstacles positioned at trigger points enhance the effectiveness of friendly fire.

Break points—also identified by target reference points—identify the closest distance the enemy can come before friendly forces move to new battle positions. Obstacles work extremely well at break points. They enhance friendly fires and gain time for friendly movement.

Use reinforcing obstacles among existing obstacles. Prepare and execute reserve targets in accordance with the commander's guidance. Make a plan—hopefully an SOP item—for the closure of these obstacles. Make full use of obstacles on reverse slopes. This adds surprise and greatly enhances weapon system effectiveness.

Obstacles with lanes or gaps must be closed once friendly forces pull back. They must be manned for security and executed on order or as directed.

The transfer of responsibility for target execution is a difficult mission. Pay particular attention if withdrawal and closure will occur in darkness. Recognition signals, guides and rehearsals are essential. Train this task before the fight—regardless of whether you are using engineers, task force scouts, or obstacle guards to close the lane.

The plan should create a maze where obstacles channelize enemy vehicles into other obstacles and engagement areas throughout the entire depth of the task force sector. Obstacles must create targets for our gunners.

You must participate in the entire planning process to advise the task force commander on an obstacle plan which supports his scheme of maneuver.

Prepare the engineer annex. You will assist the task force S-3 in preparing the engineer annex to the operations order. You will also provide an obstacle task list and an obstacle overlay. The obstacle task list should include—

- The obstacle's number, priority, type, and location.
- The unit preparing the obstacle.
- The element providing security.
- The unit guarding or executing each obstacle.

If Class IV and V are in short supply, you should designate both engineer and maneuver units for obstacle recovery.

Provide security. The maneuver commander must ensure security for prepared obstacles to prevent breaching by insurgents. You must ensure security for the engineers who are emplacing obstacles.

Provide direct fire. No obstacle should be emplaced without careful coordination between the emplacing unit and the unit covering the obstacle with direct fire. There should be pre-positioned artillery to the enemy side of all obstacles. Ensure the fire support officer plans linear artillery fire for obstacles such as minefields and wire obstacles.

If obstacles are repositioned during emplacement to improve direct fire coverage, ensure the location is corrected on the preplanned artillery list.

While emplacing obstacles, you must know the current status of the obstacle plan and keep the task force commander informed. Make sure the required minefield reports (DA Form 1355) are forwarded to the task force S-3.

Get a time sequence. The task force S-3 should give you a sequence for planning the engineer effort. He should give a NLT time to complete obstacles before a certain phase line and a final location for all engineer assets.

Assess your resources. When determining how many obstacles to emplace, consider available manpower, earthmoving equipment and logistics support.

Manpower. An engineer isn't needed to drive a picket or emplace an M21 landmine. Infantry, armor, clerks, cooks, mechanics, and others can augment the engineers. Once you determine the number of man-hours available, calculate how much can be done.

Earthmoving equipment. Blade hours dictate how many countermobility, survivability and mobility missions can be accomplished. Dedicate earthmoving equipment to digging survivability positions and providing mobility in and between positions.

Don't let dozers sit idle while maneuver commanders reconnoiter and decide on exact fighting positions for every vehicle. Use earthmoving equipment to begin countermobility missions until maneuver units are prepared to dig in.

You must schedule the use of each piece of earthmoving equipment and stick to it. In the engineer annex, show what time and how long each unit will have the earthmoving equipment. Dozers refuel often, so have fuel close by.

Logistics support. The task force commander will want an accurate estimate of obstacle material available for the defense. Get together with the S-4. You must consider both the amount of Class IV and V on hand and the amount available through logistics channels. A standardized obstacle package—part of the TACSOP—can assist in requesting barrier material.

Limited transportation assets are another problem. The task force is responsible to transport obstacle material. The task force commander must use his transportation assets according to what is most important to his scheme of maneuver. You must closely monitor movement and delivery. Material lost or in the wrong place won't win the battle.

Have priorities. Higher headquarters will designate mission priorities—generally countermobility, survivability and mobility in the defense. However, the task force commander must establish his own priorities within each mission.

Countermobility. The task force commander will give a priority to each obstacle according to its importance in his scheme of maneuver. You use these priorities to determine when obstacles are emplaced.

Survivability. The task force commander will assign a priority to each survivability mission by either company team sector, battle position or weapon system. The sequence is left up to the task force commander, but he must tell you what survivability missions are most critical to his scheme of maneuver.

Mobility. In the defense, mobility missions are limited to improving routes between fighting positions and maintaining the supply route. Use minimum effort unless your platoon has been significantly augmented by other engineer units or if mobility improvement is critical.

Plan FASCAM. Ensure the task force commander specifies where he wants FASCAM planned. FASCAM can be used to reinforce other obstacles on counterattack routes and cover lateral avenues of approach. You must be familiar with the employment of all FASCAM.

The task force engineer can make or break the combat engineers' effectiveness as combat multipliers. With experience and the support of a tactically proficient platoon sergeant, you will provide the task force commander with a solid obstacle plan and pave the way for success on the defense.

CPT Gregory R. Wine commanded Company C, 17th Engineer Battalion, 2nd Armored Division, at Fort Hood, TX. He graduated from the U.S. Military Academy and the Armored Officers Advanced Course. He is now a professor of military science assigned to the cadet command at the University of Florida.

Letters to the Editor

E-FORCE—What Impact on DISCOM?
Obstacle Belts—Germans Use Similar System

I found your spring '86 issue to be most interesting as did the German officers I am stationed with at the German Tactics Center. I would like to comment on two articles which appeared in that issue.

"E-FORCE" by MG Richard S. Kem, MAJ J. Richard Capka and MAJ Houng Y. Soo.

MG Kem's opening remarks "cleared the way" for this article. As the U.S. action officer at the German Tactics Center and deeply involved in preparing tactical map exercises for the Bundeswehr, I have gained new appreciation for the combat multiplier value of engineers.

E-FORCE is an excellent alternative to today's organization.

My concern, however, is that there was little discussion of the logistics and maintenance impact on the DISCOM.

E-FORCE would be part of a system, a division, and as such its impact on the entire system should be addressed. I would like to see a follow-on article that discusses what impact and changes such an engineer structure would have upon the DISCOM.

"Personal Viewpoints: Obstacles—Engineers and Maneuver Forces Need Common Terms."

CPT Baehre makes a good point for properly and briefly communicating the commander's intent, something the Bundeswehr learned a long time ago and still does very well today.

He offers two terms when one is sufficient to describe a concept that certainly deserves a more adequate response than MAJ Marubbio provided. The task force/battalion commander needs flexibility to shape the battlefield based upon METT-T and within the context of the commander's intent.

MAJ Marubbio's second point deals with the "unconstricted engineer estimate" that is based upon the "physical plotting of anticipated individual obstacles."

If the Army is serious about mission-type orders and the intent of such orders, then higher headquarters have no need to be concerned with plotting individual anticipated obstacles.

Higher headquarters only need to know what the subordinate's resource requirements are, relying upon the judgment of subordinates to accurately request what they require to accomplish their assigned mission within the parameters placed upon them.

MAJ Marubbio's final point that maneuver commanders are interested in individual obstacles is very valid for anything but a fast-paced, dynamic battlefield of tomorrow, or today.

The maneuver commander is interested in where he has mobility for his force and where the enemy is faced with reduced mobility, channelization and separation. The maneuver commander's engineer should be concerned with individual obstacles.

CPT Baehre's proposal appears to provide information to the comander much faster and more clearly. His proposal also follows more closely with the manner that our German counterparts follow. Their successful use of obstacles in WWII is well documented. I personally hope that CPT Baehre's proposal is given a better consideration.

LTC Gary J. Bridges
CGSC Liaison Officer
German Tactics Center

Author's Note: E-FORCE solves the maintenance dilemma that corps engineers working forward discover—the DISCOM is unresourced to provide support.

E-FORCE adds 30 maintenance soldiers to the division, 16 moving from COSCOM (20 each FSB; 10 to MSB). Now repair parts and mechanics to support the engineer battalion will be provided in each FSB. Supply/transportation increases by 4. All have been coordinated with the Logistics Center.

Bring Obstacles Doctrine In Line With AirLand Battle

In reference to your "Point/Counterpoint" in the spring 1986 issue, CPT Baehre is clearly on the right track. A similar system was proposed by MAJ Fastabend and MAJ Graves in the February 1986 *Military Review.*

The key here is the difference between data and information. The division commander and his principal engineer advisor simply cannot absorb all of the data represented by the barrier overlay as used in most units.

He needs information such as "This goose egg (obstacle zone) is 75% complete and will be finished NLT 2400 hours." The task force commander, on the other hand, wants to know about individual road craters and point minefields.

It is the brigade engineer's job to aggregate the data into information for the division engineer's use. Should data on a particular obstacle be of interest, it can be retrieved; but transmitting all data on all obstacles to the battalion TOC only serves to collapse the radio nets.

MAJ Marubbio's contention that the obstacle plan should grow from the bottom up is wrong and would prevent the effective use of AirLand Battle doctrine.

The division commander decides how he wants to fight the division and prescribes the scheme of maneuver. The last thing he needs is to have a battalion commander "shape the battlefield" and close off a major counterattack route.

The commanding general can prevent this by designating obstacle zones wherein his subordinates are free to use their initiative without further guidance, and outside of which they are forbidden to emplace obstacles without specific permission.

To the extent that maneuver commanders can be persuaded to develop a scheme of maneuver rather than asking that the engineers create an "impenetrable barrier system," the use of obstacle zones and belts can streamline the engineer's job. If the maneuver commander plans the battle and the engineer plans the obstacles so that there is no need to maneuver through the belts, then the engineers can go at full speed executing the targets as they are ready rather than going through the target turnover process.

From my perspective as a division engineer, I see nothing but advantages to bringing obstacle doctrine into line with AirLand Battle.

LTC Jon S. Behrens
Commander
7th Engineer Battalion (C)
Fort Polk, LA

E-FORCE—Don't Forget the Guard and Reserve

I read with great interest *E-FORCE* by MG Kem, MAJ Capka and MAJ Soo. It would appear that E-FORCE as described can now support the maneuver commander's combat engineer requirements.

The increase of the division's organic combat engineer battalions is not a new concept. It was discussed extensively in the late 1970s. There were too many nonbelievers at that time . . . too many senior engineer officers who felt WWII command and control doctrine would suffice and a can-do attitude would overcome the obvious weaknesses.

While it was not stated precisely, I assume the division engineer is a colonel and in essence a group/brigade commander. That seems implied by the statement, "The division engineer orchestrates the engineer effort throughout the division area." I must also assume the E-FORCE concept has not yet been blessed by TRADOC or HQDA.

E-FORCE as envisioned in the article seems to address only the 10 heavy divisions in the Active Army. Let's not forget the Reserve Components. For example, there are 4 heavy divisions in the National Guard. In addition, there are 6 separate heavy brigades in the National Guard and Army Reserve whose requirements and mission must be considered as the force structure is developed and implemented. These are not roundout brigades.

Equipping and training E-FORCE will be a challenge. At least 26 new division engineer battalions must be formed, and the 13 existing heavy division engineer battalions must be modified. With over 70% of the Army engineers serving in the Reserve Components, E-FORCE is certain to affect the National Guard and Army Reserve. They must be involved in planning from the start.

E-FORCE is the way to go. If adopted, it will be a major step in closing the credibility gap with the maneuver commanders.

COL (R) James B. Fleming
ARNG Advisor to the
Engineer School 1977-79

Author's Note: E-FORCE was conceived as Total Force—applying to all 14 heavy divisions, 10 active and 4 ARNG, and to all separate heavy brigades, active and reserve. The concept was blessed by CG TRADOC to take to HQDA. Chief Army Reserve and Chief ARNG were briefed and concur in the concept.

Letters to the Editor

E-FORCE, Let's Do It!

The E-FORCE article in the spring 1986 *ENGINEER* magazine outlines a structure that is long overdue for those of us attempting to support the combined arms team on the AirLand battlefield.

My experience during REFORGER 1985 working on the 4th Infantry Division (Mechanized) staff and two rotations at the National Training Center as a company commander supporting the 1st Brigade, 4th Infantry Division (Mechanized), fully supports the points made in this article.

On exercises like REFORGER, the division combat engineer battalion is augmented with a corps combat battalion and an engineer group headquarters. This provides more engineers; however, this ad hoc organization hinders mission accomplishment.

Command and control, communications, maintenance, and logistics are dysfunctional from the start. Valuable time and efficiency of engineer effort are lost during the initial attempt to task organize this patched together support package.

The current Army "warfight" doctrine demands that we train as we shall go to war. Even on major exercises such as REFORGER, the two weeks of field training cannot overcome the inherent problems associated with the current engineer organization.

These problems become painfully obvious at the National Training Center. The battlefield demands that engineers must prepare the terrain in a realistic manner. In this environment, the task force commander constantly demands more engineer assets.

To provide these assets, my company was augmented by a company(-) from a combat heavy battalion which performed the role of the corps combat company. The heavy engineer equipment and manpower were certainly a welcome addition to the engineer support package. However, the command and control, communications, maintenance, and logistics problems reduced the efficiency of this organization.

The command and control problems focus on the task force engineer. The engineer platoon leader is overwhelmed by his numerous responsibilities. To minimize the problems that even the best lieutenant cannot overcome, I assumed the role of the task force engineer during two rotations at NTC. This solved most of the problems for one task force. However, this created more problems for the second task force.

The decision of who should be the second task force engineer is then a toss-up between the normally associated engineer platoon leader—frequently inexperienced and trying to run his platoon—and the second company commander—who has a company staff and more experience, but is a stranger to the task force.

Further, the corps combat company is poorly equipped to survive while in support of the front line task force. Two engineer companies from different battalions supporting two task forces may "work" at NTC. Even with these problems, however, it is not the appropriate AirLand battlefield solution.

The battlefield solution is the E-FORCE.

The experience of our companies at NTC demonstrates that only a combat engineer company can provide the mobility, countermobility and survivability required by a maneuver task force.

The company commander has the experience to properly advise the task force comander and the assets to fully perform his mobility, countermobility and survivability missions. Platoon leaders can learn to lead their platoons and start to experience the complexity of supporting the combined arms team on the battlefield.

That makes sense; let's do it!

Of course it is simple to draw the charts and outline the organization, but it is quite difficult to breach the barriers to implement the E-FORCE. These barriers must be breached because engineers in the field cannot overcome the problems without a change in structure.

The E-FORCE structure is what is needed; it will solve the problems. We have the responsibility to provide quality engineer support on the battlefield, but our current organization is not the answer.

The E-FORCE is the organization that will allow us to live up to our motto of "Essayons!"

CPT Bruce A. Fink
Commander, Company A
4th Engineer Battalion
Fort Carson, CO

Obstacle Zones and Belts Work; Current Doctrine Does Not

The system of obstacle zones and belts proposed by CPT Michael Baehre in the Spring '86 issue of *ENGINEER* is the same as one described by MAJ David Fastabend and me in "Maneuver, Synchronization, and Obstacle Operations" in the February '86 *Military Review*. The similarity is no doubt due to the common experience of CPT Baehre and my co-author in the 3d Infantry Division (M).

In his reply, MAJ Arthur Marubbio of the Engineer School admits that such systems are often mentioned in the field. Indeed they are!

I have personally observed their use by the 8th Infantry Division (M), the 3d Armored Division, and the 130th Engineer Brigade, as well as the 3d Infantry Division. These units, and probably others, use zone and belt systems because they work, whereas the current doctrinal system does not.

MAJ Fastabend and I call our version an AirLand Battle obstacle concept because it supports the latest Army maneuver doctrine. The objections posed by MAJ Marubbio can all be turned to arguments in its favor.

First, he states that division and brigade designation of obstacle zones restricts the flexibility of the battalion task force commander. That's the main purpose!

AirLand Battle doctrine focuses on the enemy rather than on the terrain. Defensive operations should attempt to seize the initiative and attack. Sector assignments are likely to change.

Very liberal designation of belts and zones could ease restrictions, but if the division commander intends to shift to the offensive, his planners must facilitate maneuver by restricting subordinate obstacle efforts to designated areas.

Current systems of reserved lanes, target turnover, and breaching friendly obstacles are too cumbersome and too slow.

Give the battalion task force commander freedom within assigned belts. But keep potential maneuver areas open—to be closed with dynamic obstacles if necessary.

The second objection is that the unconstrained engineer estimate must be based on detailed plotting of individual obstacles nominated by subordinate units. Please, no!

The war will not wait the three days it takes to perform this exhaustive reconnaissance, planning, and coordination effort.

Furthermore, why should one subordinate unit be rewarded with more engineer resources just because it plans more obstacles?

FM 100-5 emphasizes the importance of speed in defensive preparations. I interpret this to mean that a division will be lucky to have 24 hours to prepare.

Let me summarize the argument presented in our *Military Review* article: Division and brigade planners must allocate units and materiel based on the commander's scheme plus their knowledge of the threat and terrain so that orders, munitions and engineer units arrive in time to prepare the battlefield.

With reason, MAJ Marubbio asks, "How can the division and brigade planners request and allocate resources based on the general definition of zones and belts?"

In order to be timely, the allocation of units and supplies will have to be made on the basis of the engineer staff officer's estimates.

Currently, such estimates are very hard to make. The Engineer School could help by developing planning factors for determining troop, equipment, fuel, and munitions resources required to achieve different levels of obstacle effect in various types of terrain.

The standard obstacle concept should be refined and generalized to predict supply consumption and work rates for committed engineer platoons, companies, and battalions.

This sort of "push" system is how munitions are provided to most of the Army's weapons systems.

The current method of trying to manage barrier munitions by "demand" from the squad level is an anomaly which frustrates engineers and logisticians alike.

My experience as a brigade and assistant division engineer does not support MAJ Marubbio's next assertion that maneuver commanders at all levels are interested in the status of individual obstacles.

As CPT Baehre points out, a system of belts and zones does not preclude tracking certain key individual obstacles. But what the maneuver commander wants most is to know the overall status of the preparation of the battlefield and the countermobility effect to be expected.

He can't make any sense of a long obstacle status list or a jumbled overlay, and the engineers can't provide such detailed information on a real time basis without an inefficient and dangerous overcommitment of command, control, and communications assets.

Detailed obstacle data—including minefield recording forms—need to be kept. But it is sufficient to compile hard copies and forward them every 12 hours or on the occasion of sector transfer.

In his "Clear the Way" column, MG Kem says that our equipment and force structure often lead others to view the engineers as cumbersome and deliberate.

We are also slowed by antiquated obstacle planning doctrine. Busy units take the time and effort to develop their own methods only when doctrinal solutions prove inadequate.

The AirLand Battle obstacle concept is more than a graphical technique; it is a complete planning system attempting to meet the needs of today's engineers and commanders.

I challenge the Engineer School to recognize that a problem exists and to help solve it.

MAJ Ralph H. Graves
Department of Engineering
United States Military Academy

Not Much Has Changed Since Kipling's Day

I was most intrigued, as a retired sapper, to see the article in the latest *ENGINEER* on the sapper, page 19.

I thought it might amuse you to see Kipling's definition as applied to Royal Engineers. I got my copy from the Library of Congress.

It strikes me that not much has changed since Kipling's day.

COL (R) Brian S. Read
Fairey Engineering

Editor's Note: Here are some excerpts from Kipling's poem, "SAPPER."

When the Waters were dried an' the Earth did appear,
("It's all one," says the Sapper),
The Lord He created the Engineer,
Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

When the Flood come along for an extra monsoon,
'T was Noah constructed the first pontoon
To the plans of Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

* * * * *

For ever since then, if a war they would wage,
Behold us a-shinin' on history's page—
First page for Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

* * * * *

They sent us in front with a fuse an' a mine
To blow up the gates that are rushed by the Line
But bent by Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

They sent us behind with a pick an' a spade
To dig for the guns of a bullock-brigade
Which has asked for Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

* * * * *

Now the Line's but a man with a gun in his hand,
An' Cavalry's only what horses can stand,
When helped by Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

Artillery moves by the leave o' the ground,
But **we** are the men that do something all round,
For **we** are Her Majesty's Royal Engineer,
With the rank and pay of a Sapper!

* * * * *

Mutter der Kompanie

Brigadier General Roland H. Zedler, commandant of the German Engineer School and Army Technical School for Structural Engineering, made the following observations at a Dining In of the 7th Combined Arms Training Center First Sergeants Course, November 1985.

Since I have been assigned to the Engineer School in Munich, I have been happy to see the very close and friendly relations which exist between the American NCOs of the U.S. garrison in Munich and the NCOs of the German Engineer School. This is important since we would be highly dependent on one another in the event of war. The better we understand one another, the better we will be able to accomplish our mission.

Both of our armies have an old expression: "The NCO is the backbone of the Army." I am convinced this is true, but what does it really mean? The backbone gives the body bearing, strength and a self-confident appearance. The same is true of the NCO. He gives the Army bearing, strength and self-confidence. Without a backbone, the body is limp. Without NCOs, an army is unstable—lacking the necessary broad-based strength and technical know-how.

The position occupied by the first sergeant within the Army is special. In the German Army there is an old, affectionate nickname for him: *Mutter der Kompanie* which literally means *mother of the company*. He is, in fact, like a mother to his troops. Without him, nothing functions. However, he often is not praised, promoted, heeded, or recognized commensurate with his importance.

Let me now offer some fundamental thoughts about the first sergeant in the 1980s:

- He cannot be desk-bound.
- He must be concerned about all soldiers entrusted to him . . . go to them . . . talk to them . . . and, particularly during exercises, he must live with them.
- He should be the mediator between the NCOs and the troops.
- He is the doorway to the company commander and commits a grave sin when he shuts off the company commander from his soldiers for bureaucratic reasons; exactly the opposite is expected of him.
- Moreover, he should be the guardian of his men, preventing them from doing anything stupid—a fatherly friend who points them in the right direction in life.

What does this mean? The first sergeant should ask his soldiers about their troubles and worries. He should take care of the sick. He should take an interest in personal events such as marriages, deaths, accidents, or illness. The duty roster of the company should be impartial and fair. It should not be left to a clerk to decide who has weekend duty.

The first sergeant must personally look after his men when they have outdoor duty or are on exercises. Day and night, under any weather conditions, he must ensure a steady supply of food, hot or cold beverages, and other necessities, particularly to those on isolated posts.

His soldiers must feel that, although they are alone at an obstacle or outpost, the first sergeant is thinking of them and will take care of them. Like a real mother, he always knows where to find his unit or subelement. Whether his soldiers are away on temporary duty or hospitalized, the first sergeant keeps track of everyone. A mother always knows where her children are, leaving none to their own fate.

The first sergeant is expected to take care of those soldiers living in the barracks, even after duty hours, on weekends, and on holidays. He must be concerned about living conditions. Quarters inspections at every opportunity and irregular times are expected. During these visits, he should keep an eye on the quiet soldiers in particular; they are often the ones confronted with problems.

A good first sergeant is open-minded to soldiers' troubles, especially to those of young soldiers. This is more important now than in the past because many families no longer provide the necessary support to young people. In many cases, life in these families is disturbed. An alert first sergeant can resolve many problems before they create discipline problems. He also tries to speak the language of the younger generation.

Sometimes this builds bridges of understanding. Often the first sergeant can gain access to a soldier's thoughts by asking about his occupational background and friends. He must look into the faces of his men. There he will see the first indications of trouble and worry. The suicide notes of many soldiers who took their own lives describe feelings of being left alone. Likewise, he may recognize the first signs of drug abuse in the expression on a soldier's face.

Usually the first sergeant is also the oldest NCO in the unit. He must be the leader of and set the example for the NCO corps—even in changing times. He must strive to keep the NCO corps together—despite the current trend to drift apart. It may be helpful to integrate the wives and fiancees into off duty events. He should school young NCOs in social manners so they feel secure in their military environment . . . and share the valuable tips and guidance he has gleaned in his career.

The first commandment for the first sergeant is *never tire*. Despite the rigorous routine and the endless stream of new faces, he must never lose heart and always be prepared to start over again. He must create a balance between administrative work and training his soldiers. A first sergeant who is devoured by paperwork is an NCO in the wrong position. Above all, a good first sergeant is dedicated to his occupation. It is not sufficient to consider his mission *just a job*.

Of course, the first sergeant must be physically fit. How could he otherwise meet the demands of his profession? How could he otherwise keep pace with his young soldiers? A first sergeant whose men regard him as *grandpa* will never have access to them.

Finally, a good first sergeant has a keen eye for detail . . . for cleanliness, order and punctuality. This applies particularly to the NCOs under his charge.

Clearly, the role of first sergeant is demanding. Only the best NCOs are called to fill it. All who are chosen for this professionally rewarding assignment should say, "I am proud to be a first sergeant."

Brigadier General Roland H. Zedler, now commandant of the Engineer School and Army Technical School for Structural Engineering (Pionierschule und Fachschule des Heeres fuer Bautechnik) was deputy commander of the 6th Armored Infantry Division and commander of the Divisional Troops before his current assignment. He is the author of numerous military publications dealing with command and control, including "Command and Control Systems of the Bundeswehr."

Hotline Q & A

Q. What are recent changes in engineer organizations?
A. The *engineer combat battalion (heavy)* has been reclassified to a Category II unit. This opens the entire battalion to women. The maintenance company and the headquarters company have been consolidated into a headquarters and support company.

The S-1 sections of the *corps mechanized* and *corps wheeled battalions* are being standardized with the S-1 sections of other engineer units. Two reconnaissance sections are being deleted, and the medical section is being reduced. The line companies remain unchanged.

Diving assets are being removed from all engineer TOEs and consolidated into diving detachments.

Topographic assets are being removed from the topographic battalion. Modular teams are being formed by functional area and will be resourced as each MACOM determines necessity.

Quarry assets are being formed into modular teams and are being removed from all engineer TOEs. Each MACOM will resource the requirements.

Q. How do we install an AN/GRC-160 radio on the M929 dump truck?
A. The recommended method is to order the general purpose kit MK1454 (NSN 5820-00-351-3003). See SB 11-131, *Vehicular Radio Sets and Authorized Installations,* for more information.

Q. Can Bangalores defeat all known single-impulse antipersonnel mines and will they defeat any known antitank mines?
A. Bangalores will not defeat the Soviet PFM-1 antipersonnel mines and are not recommended to breach minefields containing antitank mines.

Q. What is required to conduct a river reconnaissance?
A. The commander dictates what information he wants about the river. Typical requests include—

Hasty route reconnaissance — Subordinate unit will turn in a DA Form 1711-R and an overlay identifying water features. The commander may request other reconnaissance forms on specific water features, but time is a factor.

Deliberate route reconnaissance — Subordinate unit should have time to conduct a thorough reconnaissance of the area. The unit will turn in a reconnaissance report (DA Form 1251 or 1252) on each ford or ferry.

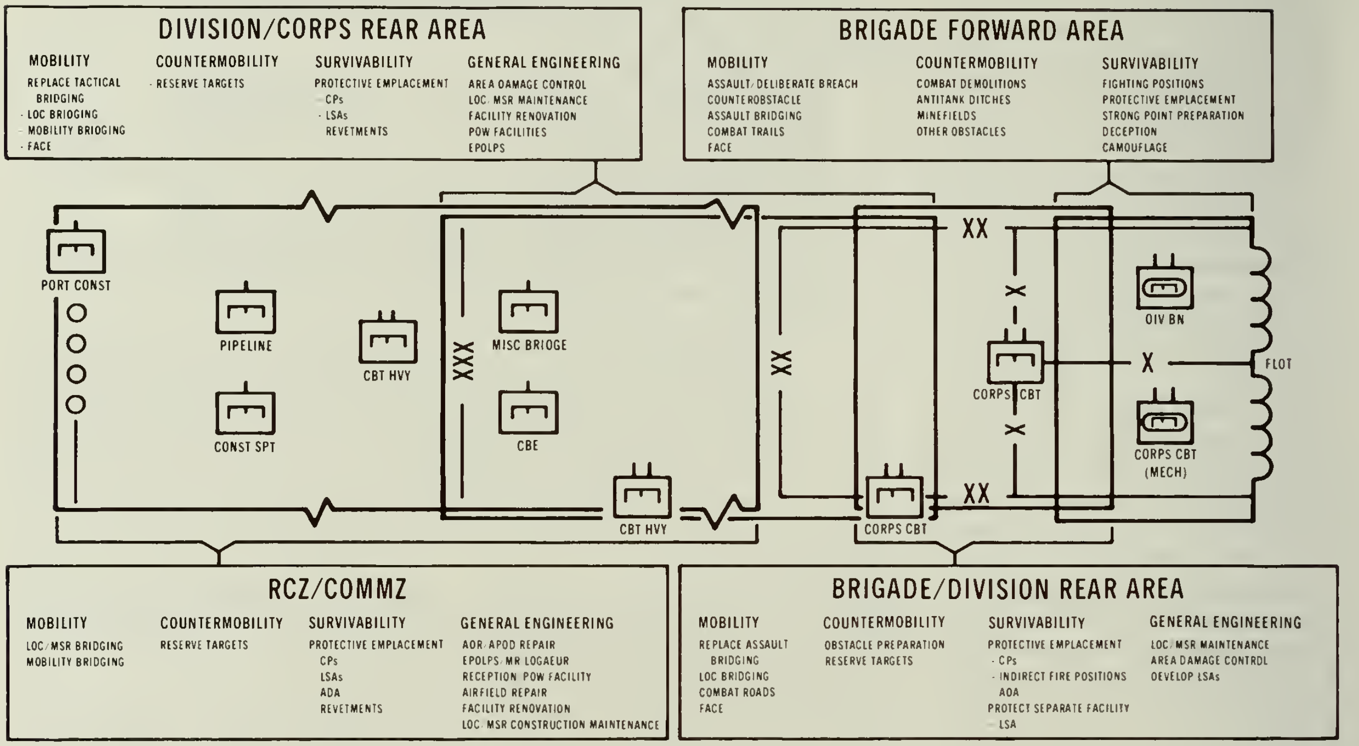
Engineer reconnaissance — Subordinate unit will conduct a reconnaissance for water points or possible water points. The unit can record several water points on DA Form 1711-B.

Q. How can I get the Combat Engineer Game?
A. The Combat Engineer Game (GTA 5-14-1) is available from training audiovisual support centers (TASCs) located at most installations.

Do you have problems, questions or comments relating to engineer doctrine, training, organization, or equipment? Call the Engineer Hotline. You'll receive a reply within 3 to 15 days.

The Hotline telephone number is (703) 664-3646; WATTS 800-336-3095, extension 3646; or AV 354-3646.

Engineer Battlefield Layout



ADA	Air defense artillery	EPOLPS	Emergency POL pipeline system	LSA	Logistics support area
ADR	Airfield damage repair	FACE	Forward aviation combat engineering	MRLOGAEUR	Minimum required logistics augmentation, Europe
APOD	Aerial port of debarkation	FLOT	Forward line of own troops	MSR	Main supply route
COMMZ	Communications zone	LOC	Lines of communicaton	RCZ	Rear combat zone
CP	Command post				

by CPT Daniel Russell

Engineers perform a variety of support missions throughout the depth of the battlefield. These range from sapper-oriented combat engineering for forces facing the enemy to specialized general engineering like port construction for the theater.

The figure depicts a typical division slice of engineer units and their missions. The battlefield is divided into four regions:

- The brigade forward area.
- The brigade/division rear area.
- The division/corps rear area.
- The RCZ/COMMZ.

They overlap because in reality the boundaries for engineer missions aren't clearly delineated. The overlap also emphasizes the need for coordinated engineer effort.

Most missions in the brigade forward area and the brigade/division rear area are mobility, countermobility and survivability tasks. Therefore, troops near the FLOT are primarily combat engineers. Mechanized combat engineers operate within the brigade forward area, and wheeled combat engineers work in the brigade/division rear area.

Moving rearward from the FLOT to the RCZ/COMMZ, the missions shift to general engineering and survivability. Construction engineer units (combat heavy, equipment companies and bridge companies) operate in the division/corps rear area.

Specialized units such as pipeline and port construction companies are located in the RCZ/COMMZ.

CPT Daniel Russell is assigned to the Force Design Branch of the Directorate of Combat Developments at the Engineer School. He has served as a platoon leader and XO of the 814th Engineer Company (RB) in Hanau, Germany. He is an EOAC graduate and has a degree in mathematics from the University of Texas at Arlington.

Army apprenticeship program

by Bruce Barclay

Military engineers can earn journeyman status in technical trades while in the Army. Soldiers receive apprenticeship credit for military training in such diverse specialties as plant equipment operator, surveyor, rigger, firefighter, and electrician.

The Army Apprenticeship Program was created in 1973 in cooperation with the U.S. Department of Labor. Studies show that those who complete apprenticeship programs learn faster, earn more, and often become supervisors.

To qualify, you must learn your occupation through on-the-job training and technical instruction. Apprenticeship involves at least 2,000 hours experience with manual, mechanical or technical skills related to commercial industry. It cannot involve selling, management, clerical work, or one of the professional fields.

Enrollment

Your post's education center handles apprenticeships. A counselor will explain the options available for your MOS and provide the forms. You must be in the Active Army and hold the required MOS as a primary or secondary specialty.

On-the-Job Training

Once enrolled, you must keep a log of your work experience on DA Form 4567-R, *Apprentice Daily Work Experience Record.* You may earn up to 132 hours of credit a month. Your supervisor initials the entries and notes special pieces of equipment or unusual projects. At least quarterly, the local education center checks your records.

You may receive credit for experience or training while on active duty before you joined the program. You may also transfer credit if you were enrolled in a federally or state-approved apprenticeship program before enlisting.

Technical Instruction

Each year, you must complete 144 hours of related military or civilian instruction—resident or nonresident. The Engineer School evaluates civilian courses.

Certification

An Army apprenticeship usually takes longer than one enlistment. Most programs call for 6,000 to 8,000 hours of hands-on experience and 432 to 576 hours of related instruction. Your documentation of work experience and related instruction is reviewed by the education center, the Engineer School, and TRADOC. The U.S. Department of Labor's, Bureau of Apprenticeship Training issues a certificate of completion.

If you leave the Army before completing your apprenticeship, the education center provides a record of enrollment, DA Form 5004-R, that documents your work.

The U.S. Department of Labor considers Army apprenticeships equal to civilian programs and recommends that employers consider military apprentices as journeymen.

For more information, write: Commandant, U.S. Army Engineer School, ATTN: ATZA-TD-UI (Mr. Barclay), Fort Belvoir, VA 22060-5291, or call (703) 664-2498, AV 354.

Bruce Barclay is the Engineer School's action officer for the Army apprenticeship program.

Engineer School Apprenticeship Program

Program, Number and Skill Code	MOS	DA Pam
Plant Equipment Operator 99901-01	62G, 62H	621-76
Grading and Paving Equipment Operator 99901-02	62E, 62H, 62J	621-77
Heavy Duty Repairman (Construction Equipment) 99901-03	62B	621-78
Universal Equipment Operator (Construction Equipment) 99901-04	62F	621-79
Carpenter 99901-05	51B	621-84
Plumber/Pipefitter 99901-06	51K	621-85
Electrician 99901-07	51R	621-86
Firefighter 99901-08	51M	621-116
Refrigeration/Air-Conditioning Repairer-Servicer 99901-09	52C	621-115
Lithographer (Offset Press Operator) 99901-10	83F	621-112
Drafter (Architectural) 99901-11	81B	621-113
Industrial Electrician/Repairer 99901-12	52E (Electrical ASI)*	621-117
Power House Electrician Repairer 99901-13	52E (Mechanical ASI)*	621-118
Rigger 99901-14	12B, 12C, 51C, 51H	621-123
Surveyor (Engineering) 99901-15	82B, 82D	621-107
Lithographer Plate Maker 99901-16	83E	621-142
Stripper, Photolithographic 99901-17	83E	621-141
Photographer, Lithographic 99901-18	83E	621-143

*A 52E can enter either 99901-12 or 99901-13. The indicated ASIs show which branches of 52E perform the specific duties for each apprenticeship program.

Career Notes

Commissioned Officers Branch

Joint Assignment Proposed:

You should have at least one joint assignment if you want to qualify for general officer. Recent reemphasis by the Vice Chief of Staff, U.S. Army, and DoD Directive 1320-5 outline the requirement for a joint assignment. This requirement can be satisfied by serving in one of the following:

- Office of the Secretary of Defense.
- Office of the Joint Chiefs of Staff.
- Joint, combined, allied, or unified commands.
- Department of Defense agencies.
- Other government agencies.
- Military assistance advisory group or military group.
- Exchange tours with allied or sister services.

Engineer Advanced Civil School Board:

Branch-qualified officers interested in attending advanced civil schooling in FY 87 should apply for graduate school under provisions of AR 621-1. If you are interesting in teaching at the United States Military Academy, attending school fully funded, or entering the degree completion program, you must send your application to Engineer Branch before August 30, 1986.

CSC Schooling for LTC Promotion:

If you have not completed Command and Staff College (CSC) schooling before the LTC promotion board meets, you will not be selected.

A proposal to make CSC a requirement for promotional consideration could be in effect in 1988—primary zone for year group '73.

You are eligible for selection to resident CSC for four consecutive years—beginning the year you are selected for major. If you are not selected by the second year, start nonresident Army Command and General Staff College (CGSC)—the only nonresident qualifying school. This gives you enough time to complete the nonresident course, but does not affect your selection for the resident course.

About 50% of a year group will be selected for resident schooling and 70% for promotion.

CPT/CVI Board:

The December CPT/CVI board was a best qualified, not fully qualified board. Results were released in March.

- Individuals selected for captain who requested Voluntary Indefinite Status were selected for CVI.
- USAR officers must initiate the request between the 24th and 27th month of active federal commissioned service.
- There is no procedure to notify officers of their eligibility.
- Late requests will not be accepted.

NCO and Enlisted Soldiers Branch

NCO Notes:

All promotable E-5s who did not attend PLDC were removed from the standing promotion list July 1, 1986. Beginning March 1, 1987, you must have a high school diploma or its equivalent to appear before an E-5 promotion board.

Attention: 51H E-6s and E-7s. You must review and update the principal duty block on your DA Form 2-1, Section VII, Record of Assignment. Often, the principal duty title of *construction foreman* or *construction supervisor* is masking leadership positions (*squad leader* or *platoon sergeant*). Only a cross-reference with the appropriate EER details these assignments as leadership positions.

Recent promotion boards indicate successful leadership assignments are essential to recommendations for promotion. If your DA Form 2-1 states *construction supervisor* or *construction foreman*, you might not receive credit for serving in a leadership position. Your MILPO can add *platoon sergeant* or *squad leader* to your principal duty title.

MILPERCEN Hotline:

The Enlisted Engineer Career Branch now has a 24-hour Hotline—(703) 325-7150, AV 221-7150. When asked for the number of the person you are calling, dial 325-7710. Then follow further instructions. Leave your full name and social security number. Your career advisor will respond the following day during normal office hours (0700-1530).

Engineer Enlisted Personnel Office:

		CMF	**(703) 325-*xxxx* AV 221-*xxxx***
Branch Chief	LTC Jack E. Weber		*8329*
Branch SGM	SGM James M. Welsh		*8327*
Senior Career Advisor	MSG William Kagee	12/81	*7710*
Senior Civilian Supervisor	SFC James Livers	12/51/81	*7710*
Career Advisor	SFC Richard Krohn	51	*7710*
Senior Career Advisor	SFC Lowell Abney	12	*7711*
Civilian Supervisor	Ms Toni Gibson	12	*7710*
Civilian Supervisor	Mr. Steve Patchan	51	*7711*
Professional Development NCO	SFC David Broadus	12/51/81	*7710*
Schools Assignment Manager	Ms Cleo Dugger		*8326*

(continued from inside front cover)

train, plan, research, investigate, reflect, and debate, we must remember some good counsel from *Infantry in Battle* that "elasticity of mind" is an "indispensable requisite when practicing the art of war."

As former TRADOC Commander GEN William R. Richardson said when he introduced the newly revised edition of FM 100-5, "Every officer must understand that the great value of our doctrine is not the final answers it provides but, rather, the impetus it generates toward creative and innovative solutions to the problems of combat."*

MAJ David J. Block and MAJ Gary W. Baumert were partners in a research project on the effects of minefield patterns on the probability of kills on armored vehicles during a master's degree program in operations research and systems analysis at Florida Institute of Technology.

MAJ Block is currently assigned as an ORSA analyst for casualty estimation at HQDA, ODCSPER. Previous assignments include experience in minefield emplacement as the company commander of the 84th Engineer Battalion in Vietnam. He was also a company commander with the 293rd Engineer Battalion in Germany. In addition to a master's degree at FIT, he holds a bachelor's degree in engineering from Alfred University and an MBA from Central Michigan University.

MAJ Gary W. Baumert is an ORSA analyst for integrated warfare at the U.S. Army Concepts Analysis Agency. He has served as XO of Company B, 11th Engineer Battalion (CBT) at Fort Belvoir, and commanded chemical units for the 9th Infantry Division and the 56th Field Artillery Brigade (Pershing) in Germany. He holds a bachelor's degree in zoology from the University of Colorado in addition to a master's degree from FIT.

Engineer Solution

Step 1. Type of fence

a. Determine the perimeter 200 + 400 + 450 + 430 = 1,480 meters

b. Determine the effective length 1,480 x 1.10 x 2 belts = 3,256 meters

c. Determine the number of 300-meter sections 3,256/300 = 10.8 sections

d. Determine the logistics for the three fence types (Use Table 4-3, page 109 in FM 5-34)

	4- and 2-Pace Wire 10.8 sections (300m each)	**Concertina** 10.8 sections (300m each)
Long pickets	10.8 x 100 = 1,080	10.8 x 160 = 1,728
Short pickets	10.8 x 200 = 2,160	10.8 x 4 = 43.2 round up to 44
Reels of barbed wire	10.8 x 15 = 162	10.8 x 3 = 32.4 round up to 33
Rolls of concertina		10.8 x 59 = 638
Man-hours (MH)	10.8 x 59 MH x 1.2 (U-shaped picket value) x 1.5 (night factor) x .67 (experienced troops) = 768.5 MH	10.8 x 30 MH x 1.5 (night factor) x .67 (experienced troops) = 325.6 MH

Combination Fence

	1 belt of 4- and 2-pace wire	1 belt of concertina
Long pickets	100 x 4.93 = 493	160 x 4.93 = 789
Short pickets	200 x 4.93 = 986	4 x 4.93 = 20
Reels of barbed wire	15 x 4.93 = 74	3 x 4.93 = 15
Rolls of concertina		59 x 4.93 = 291
Man-hours	59 x 4.93 x 1.5 (night factor) x .67 experienced troops) = 292 MH	30 x 4.93 x 1.5 (night factor) x .67 (experienced troops) = 149 MH

TOTAL 292 + 149 = 441 MH

e. You have enough short pickets for either the concertina or the combination fence. Since time is critical, the concertina fence will require fewer man-hours for construction.

Step 2. Total man-hours

a. Calculate the mortar emplacement man-hours.

81mm mortar emplacements	3 x 12 =	36
4.2-inch mortar emplacements	2 x 29 =	58
b. Add the man-hours for concertina.		325.6
	TOTAL	419.6 MH

---

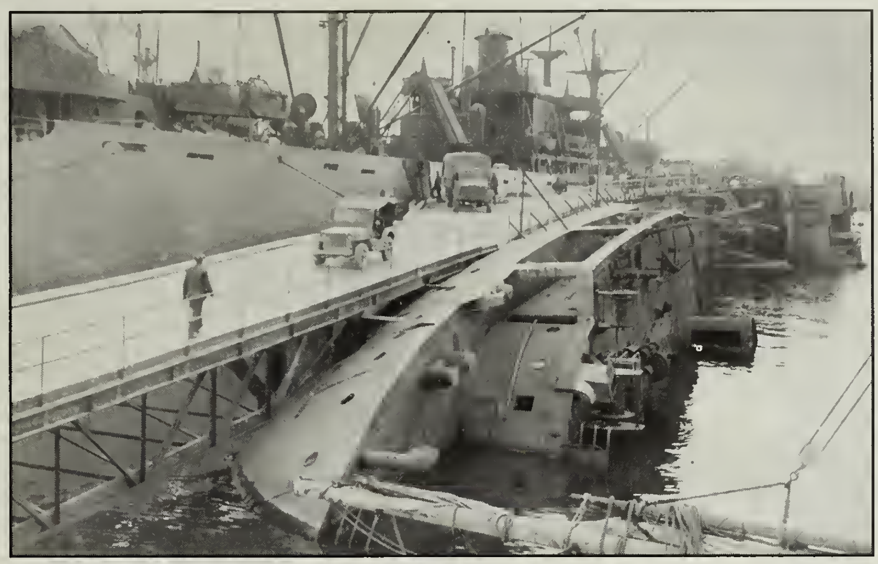
*GEN William R. Richardson, "FM 100-5: The AirLand Battle in 1986," *Military Review*, March 1986.

Past in Review

Engineers in Italy

The Port of Naples

by Dr. William C. Baldwin
Office of History, OCE



Engineer ingenuity converted sunken ships into pier supports, opening the Naples port within 48 hours. Turning defeat into an asset, engineers thwarted German attempts to close the port.

Photo: Signal Corps

The first major western Allied landings on the European continent during World War II came in the summer of 1943. After the conquest of Sicily, the British Eighth Army crossed the straits to the tip of the Italian peninsula.

A few days later, on September 9, 1943, LTG Mark W. Clark's Fifth Army—composed of an American and a British corps—landed on the beaches around Salerno, just south of Naples. Although Italy surrendered on the eve of the Salerno landings, the Germans offered strong resistance. The Fifth Army did not reach the port of Naples—its first major objective—until October 1.

Naples was the second largest port in Italy, and Fifth Army planned to make it an important logistical base.

Before Naples' capture, the invasion force brought its supplies and equipment across the Salerno beaches. However, in late September a violent storm disrupted unloading for several days. By October 6, Fifth Army had only a three-day supply of gasoline. With British and American troops pushing north of Naples to the Volturno River, it was essential to open the port and establish a firm logistical base.

Allied bombings and German demolitions left the city and port in shambles. The Germans sank 32 large ships and hundreds of smaller vessels in the harbor. Many were next to the piers the Allies would need for unloading. German engineers wrecked all the cranes in the city, using demolitions to topple wharf cranes into berthing spaces.

In the port area, they destroyed large buildings and warehouses that had escaped Allied bombing—making sure the debris blocked streets, wharves and berths. To complete their denial operations, the Germans disrupted the railroads, water supply, sewers, and electrical facilities. The city of Naples and its port required extensive, rapid rehabilitation before they could support the Fifth Army.

On the morning of October 2, 1943, engineer operations began. Troops from the 1051st Engineer Port Construction and Repair Group began surveying the damage in the harbor while soldiers from the 540th Engineer Combat Regiment and the 111th Engineer Combat Battalion cleared rubble from the streets and quays.

The most pressing task was to provide berths so large cargo vessels—called Liberty ships—could unload at piers. Scuttled ships blocked most of the piers but removal would be too difficult and time-consuming. The engineers decided to improvise berths by incorporating the bodies of downed vessels into the piers.

Starting with the ships sunk on an even keel, engineers removed the superstructures and built timber and steel ramps over the ships. Liberty ships could then tie up next to the sunken vessels and unload into trucks waiting on the ramps.

One scuttled ship lay on its side, but it had a flat bottom so the engineers built a ramp on the side of the sunken vessel, and Liberty ships tied up alongside to unload. In addition to opening berths, engineer units of BG Arthur W. Pence's Peninsular Base Section cleared roads; repaired rail lines; and rehabilitated the city's water, sewer and electrical systems.

On October 4, the first Liberty ship unloaded cargo in Naples. Three days later, 3½ Liberty ship berths were available. By the end of the month, engineers had opened 13½ berths for Liberty ships and 6 for smaller vessels. Engineer ingenuity—symbolized by the improvised piers in the harbor—helped provide Fifth Army with a port and the logistical base for the long and difficult campaign to push the Germans out of Italy.

Suggestions for further reading:

Engineer History, Mediterranean Theater, Fifth Army, 3 vols.

COL Joseph S. Gorlinski, "Naples: Case History in Invasion," *The Military Engineer* 36 (April 1944): 109-14.

Latin America is "where the action is" for realistic training (story, p. 17). Here, the 205th Engineer Battalion, Louisiana National Guard, constructs one of many low-water crossings during Blazing Trails in Panama.

Photo: CPT Daniel B. Miles Jr.

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ENGINEERING

Engineer

HE MAGAZINE FOR ARMY ENGINEERS

FALL/WINTER 1986

COMBAT ENGINEER/TOPOGRAPHIC ENGINEER TEAM

ALSO: LIGHTENING THE LIGHT ENGINEER'S LOAD   THE BLADE EFFORT TRIANGLE
THE PROFESSIONAL ENGINEER EXAM

A Personal Viewpoint

LIGHTENING THE LOAD OF THE LIGHT ENGINEER

by 1LT Thomas P. Smith

Of necessity, most of the light engineer soldier's load will be demolitions—cratering roads, knocking down walls and felling trees to create landing zones or to build expedient bridges.

But the Engineer School, the Waterways Experiment Station and the Army Materiel Command are realizing that the demolitions load is too heavy. Unless it's compact and versatile, it's incompatible with light engineers.

For example, a road crater currently takes up to eight 40-pound cratering charges—charges that eat space and can only be used for one purpose—making craters. Similarly, Bangalores are bulky and tailored to a specific task.

Last July, the 65th Combat Engineer Battalion, 25th Infantry Division (Light), helped the Army experiment with several explosives systems now under research and development for heavy forces, hoping they would hold promise for the light.

Under the supervision of WES, we tested—

- Self-forging fragment weapons system ballistic disks.
- XM-268 slurry.
- The rifleman's assault weapon.

We wanted to know not only whether ballistic disks will breach walls, but can they be hand-packed and fired from long distances? And can materials for the disks be found and fabricated on the battlefield?

We were interested not only in whether slurry creates better craters, but will it also breach walls? And can it be repackaged into flexible, backpackable loads?

The results raised some interesting possibilities, and the Engineer School has asked WES to follow up with further research.

Self-Forging Fragment Weapons System

Ballistic disks—copper or aluminum disks of varying shapes and thicknesses—were tested. This type of system is already widely used in antiarmor munitions.

The disks weigh only four pounds and don't take much space. They offer light engineers a possibility for breaching walls and obstacles (or hitting targets such as fuel storage tanks) from extended standoff distances.

The disks were placed inside short lengths of PVC pipe and packed on one side with C4—the engineer's most versatile explosive.

The disks worked well against concrete walls at a standoff distance of 20 feet—blowing a 12-inch hole in reinforced concrete that was big enough for a soldier. It did not cut the rebar, however—a deficiency that must be overcome by research and development.

The 65th also experimented with the ballistic disks as a way to make one-man fighting positions by firing the disks directly at the ground. The results were less than hoped, but research efforts could improve the explosive foxhole digger concept.

Overall, the tests demonstrated that the disks forge a slug that travels accurately over extended distances and offer a prospective low volume, lightweight breaching capability.

Slurry

If XM-268 slurry—a liquid explosive nearing the final stages of development—can be packaged for light soldiers, it offers an excellent alternative to standard military cratering charges.

The slurry consists of two nondetonatable chemical ingredients that become explosive when mixed.

It is under consideration as the liquid explosive for the Tactical Explosive Systems—to reduce embankments and create antitank ditches and road craters for the heavy force. Normally, it comes in 55-gallon drums to be mixed in large batches.

Possibly, smaller quantities could be packaged so soldiers could carry the ingredients in their rucksacks and mix them without special equipment.

During experiments, the 65th successfully devastated a triple-standard concertina obstacle by pouring the slurry, like paint, into 8-foot lengths of schedule 40 PVC pipe.

A rag was stuffed in one end, then chemicals were poured in. The explosive was primed, and another rag was used to plug the pipe. Soldiers spent only five minutes preparing three pipes—demonstrating the slurry is easy to use if a suitable container can be improvised.

The slurry also created a road crater larger than the conventional 40-pound cratering charge.

In another experiment, the 65th poured the slurry into an MRE bag and taped the bag to a telephone pole. One pound of the explosive cut a twelve-inch-diameter pole.

Rifleman's Assault Weapon

The RAW also offers interesting possibilities as a relatively lightweight, compact alternative to recoilless weapons like the 90mm rifle and the LAW.

This rifle-launched munition, which is in the early design stages, weighs less than 7 pounds. It fires lines of sight with little backblast.

The RAW blew a hole 12 inches in diameter in a 12-inch-thick, reinforced concrete wall. In an 18-inch-thick wall, 3 rounds produced destructive spalling; 5 breached it.

By comparison, it took 3 rounds to breach a 23-inch wall using the shoulder-launched multipurpose assault weapon—now used by the Marine Corps.

Potentially, the RAW offers light infantry soldiers high firepower without significantly increasing their load.

(continued on page 40)

Engineer

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On the Cover

Topographic engineers are a force multiplier for the combined arms team.

Art: Jeanne Elmore

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CLEAR THE WAY

by MG Richard S. Kem, Commandant, U.S. Army Engineer School

View terrain through the eyes of topographic engineers

Terrain must drive a commander's concept of operation. But too often its effects and limitations are considered after the fact or not at all.

When this happens, we sell the METT-T analysis short and risk self-defeat...because two of those ***Ts*** are crucial to the way commanders prepare the battlefield:

- ***T*** for terrain because you don't just consider it, you can do something about it.
- ***T*** for time available because if you fritter away time trying to develop a concept, you can't shape the terrain to your advantage.

Thus, all combat engineers have a stake in the topographic mission. We must give commanders the answers they need to maneuver in the right place...without wasting resources. If we succeed, this may well be our greatest single contribution to future battles.

That's why all combat engineers must be the commanders' experts on the use of terrain and view terrain through the eyes of the topographic engineer. Our goal must be to get commanders to assess terrain implications ***before*** they prepare their commander's concept of operation.

We recently revised Army doctrine for topographic operations to clarify intelligence and engineer staff responsibilities at all levels of command. This issue of ENGINEER offers a preview of the new doctrine, FM 105-5, *Topographic Operations,* which will be published during FY 87.

The division engineer, in particular, has ***new*** responsibilities as the chief terrain advisor to the division commander. The brigade engineer must fulfill this role for the maneuver brigade commander.

Although the G-2 will continue to task the terrain team working in the All Source Intelligence Center at division, division engineers—who, lamentably, have often had little interaction with terrain teams—must learn to tap this resource. An NCO from the terrain team will support the division engineer by working in the assistant division engineer's office.

The division terrain team is also being expanded to meet the growing demand for terrain analysis.

Terrain analysis has come a long way since 1981 when the first division terrain teams were fielded and commanders and staffs at all levels routinely failed to consider terrain while developing their operational plans.

When tactics were taught, instructors would sweep their hands across the wall map, moving divisions here and there as if anything were possible. Problems were assumed away, *"Move the main attack along Avenue Strike,"* regardless of terrain realities...realities like narrow corridors, poor off-road mobility and difficult gap crossings that literally pinch the attacking brigade down to a single column of moving tanks.

That picture has changed dramatically. Terrain teams are now staffed with highly qualified enlisted soldiers and warrant officers who have access to tactical terrain analysis data bases and the All Source Intelligence Center.

The result: commanders are discovering the value of consulting their engineers. For example, at Fort Bragg the G-3 once announced the terrain team had saved the 18th Airborne Corps from certain disaster by determining that the terrain was ill suited for the airborne, airmobile and mechanized infantry operations envisioned in the commander's initial concept.

Similar lessons have been learned in other divisions and corps. Thus, the expectations and demands on engineers are growing. You must acquire terrain sense and be prepared to integrate your understanding of terrain into maneuver and firepower planning. You must be able to navigate with assurance...to apply tactical principles to infinite varieties of terrain quickly and intuitively...to recognize the effects of weather on terrain and battlefield operations.

All combat engineers must be closely allied with their topographic counterparts. Get to know each other personally—share one another's expertise. Get the special security clearances you need to learn the capabilities of terrain analysts working with the All Source Intelligence Center.

You must know how tailored products derived

BRIDGE THE GAP

by CSM Matthew Lee Jr., U.S. Army Engineer Center and School

There is something unique about a map. It's worthless unless it shows terrain of immediate interest. And then it's the most important piece of paper in the world.

Without a map to negotiate the terrain, you are quite simply and literally lost.

That was never clearer to me than while I was at a Chinese rough terrain school in Taiwan—***rough terrain*** meaning you must air drop into any terrain and do your job.

In the haste to deploy, the American members of the party jumped without a map. We landed in a rugged area—two men shattered their legs—and we hadn't a ghost of an idea where we were. We had radios, but without a map how could we tell the rescue party where to find us?

Some of us struggled our way to a road. But which road? Where did it go?

An operation that should have taken 4 hours took 15 while the injured soldiers, one caught in a tree, waited—all for want of a map. A simple piece of paper was the vital missing link.

A map is your eyes beyond your eyes—it lets you see miles in front of you, to your right, to your left, and behind.

Wrapped in mylar, it's the record where you make notes on your surroundings. It's where you identify your route and the conditions you found. What's been built? What's been demolished? How has mother nature altered the terrain? Are the road, bridge and soil classifications accurate?

At the end of each mission, you must share your map notes. They hold invaluable information for the soldiers who come next. But only if topographic engineers get the chance to incorporate your findings into their terrain data bases and pass the word.

If you think maps are worthless, you haven't learned their language. Maps are keepers of the faith for soldiers who know how to read them.

They tell you what's on the other side of the hill...where the enemy is likely to hide...how steep the slope is...whether there is a short cut...where the next drop zone will be...where to stash a food cache, look for water or plan a rest stop.

In Vietnam when my reconnaissance team went out, the first thing we asked for was a map. When I was chased, I'd throw everything away except my map, my compass and my weapons. If the pursuit continued, I'd shed the weapons; but I never gave up my map or the compass around my neck. They were the keys to coming out of the jungle.

It is imperative that every engineer soldier be able to use a map as well as he uses a dozer. If you are set down by a river and told to build a bridge, you might as well not start if you don't have a map. That map is as essential a piece of your equipment as the reinforcement bar that goes into the bridge.

After all, there is something that sets maps apart from the rest of a soldier's equipment. The infantryman can shoot his rifle, the aviator fly his plane, the engineer operate his dozer anywhere in the world. But a pack full of the maps of Europe and Korea won't help you in Grenada.

A map is worthless unless the terrain is of immediate interest. And then it's the most important piece of paper in the world.

---

from terrain data bases can be used to guide tactical decisions and learn how you can help fill voids in those data bases during reconnaissance missions.

Finally, give high priority to ***your responsibility*** to understand terrain...to be the maneuver commander's expert on terrain, terrain effects on operations, movement through terrain, and terrain reinforcement through obstacle emplacement and construction of fighting positions.

Terrain analysis is the linchpin of the mobility, countermobility, survivability and general engineering missions...the heart of our contribution to AirLand Battle.

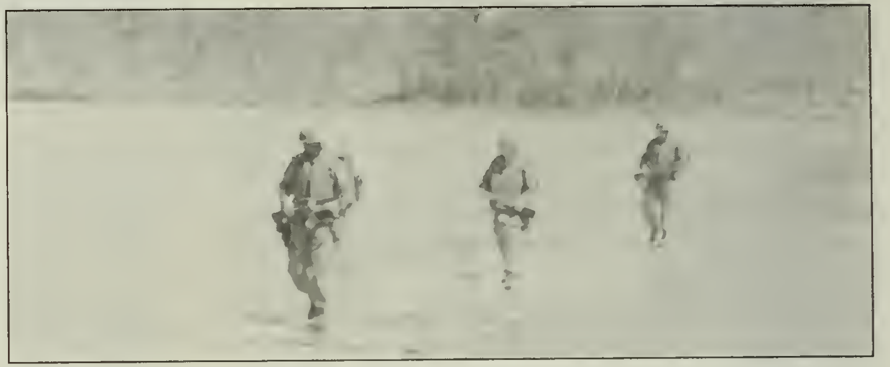
Assault River Crossing Operation

During a recent field exercise, Company A, 326th Engineer Battalion (Air Assault), built an expedient footbridge using aircraft cargo pallets. This bridge enabled infantry units to maintain contact with opposing mechanized forces without losing momentum.

The engineers used heavy drop pallets and 463L aircraft cargo pallets to build the bridge. Before the crossing started, engineers spanned the river with two steel cables. Anchored with deadmen, these cables provided extra stability for the bridge.

The rest of the construction was easy; they floated the pallets on the water and, using rings on the pallets, attached the pallets to each other with snap links. Finally, they snapped the bridge to the cables. The entire operation was performed quickly and quietly.

Lessons learned on the operation include—



- The 463L pallets are easier to use than the heavy drop pallets. Construction with 463Ls took half the time as with heavy drop pallets.
- Using the cable, 100 meters of bridge can be built in 1 hour.
- The cables are not necessary, but add stability when crossing troops.
- Since each pallet can hold the weight of a man and his equipment, this bridge could span any gap.
- Kedge anchors or shore guys could be used on bridges spanning rivers with strong currents.
- Because all preparation is below ground (deadmen) or below water (cables), equipment may be placed without detection by aerial reconnaissance.
- An entire infantry battalion task force, including slice elements, can cross in under 3 hours.

Engineer Mechanization

Engineers from the 54th Engineer Battalion convoy M577 armored personnel carriers from the railhead to the motor pool. The 54th and 82d Engineer Battalions received APCs as part of a plan to change V and VII Corps engineer units from wheeled to mechanized TOEs. Three more corps combat engineer battalions—the 317th, 9th, and 547th—were mechanized in FY 87. The 78th and 237th are to be mechanized by FY 88.

Units stationed at Fort Ord, CA, were the first to receive the M9 armored combat earthmover as TOE equipment in May 1986. The fielding came after 4 weeks of new equipment training, which included classes in operator/organizational maintenance and tactical employment. Many other units are scheduled to receive the ACE in the near future.

MINE WARFARE VIDEO AVAILABLE

A 17-minute video tape, TVT 6-135, entitled "Employment of FASCAM" (family of scatterable mines) was distributed to TASCs in mid-November 1986. The tape provides the maneuver commander and combat engineers with information on the use and capabilities of these rapidly deployable mines. If unavailable at your local TASC, the tapes may be obtained from—

US Army Audio/Visual Center
Joint Visual Information Activity
ATTN: ASNV-OJVT-ID (McIntire)
Tobyhanna Army Depot
Tobyhanna, PA 18466-5102

School News

Department of Military Engineering (DME)

BNCOC Changes:

Bridge crewmen who graduated from the 12C primary technical course before 1 June 1986 should attend 12B30 combat engineer BNCOC to receive credit for BNCOC attendance. This course provides BNCOC leadership training for skill level 2, but contains more advanced skill level 3 technical training.

Graduates of this course are proficient in skill level 3 tasks and have received the progressive and sequential training required for NCOs.

The 12C20 BNCOC combines the Sergeants Major Academy skill level 3 leadership training with skill level 2 technical training. Graduates of this course, which started at Fort Belvoir in June, receive credit for attending BNCOC.

A 12C30 BNCOC for bridge crewmen will start at Fort Leonard Wood, MO, in FY 89. At that time, 12C soldiers will no longer attend the 12B30 combat engineer BNCOC.

Directorate of Combat Developments (DCD)

Management Initiatives:

DCD is now applying two new management tools, the TRADOC Organization Management System (OMS) and the 1987 Engineer Functional Area Assessment (FAA).

The OMS will make it easier to spot breakdowns between force structure and the personnel and equipment aspects of TOEs.

The 1987 Engineer FAA, scheduled for presentation to the Vice Chief of Staff of the Army in January 1987, will analyze specific units to identify and correct problems with training, doctrine, force structure and personnel.

Using these techniques, DCD plans to survey selected engineer units to confirm what equipment field units have and correct the accuracy of TOE data. Engineers in the field can expect to hear from this property-book-level survey beginning in September 1987.

For more information, contact LTC Robert H. McDonald, ATZA-CDO-FI, Fort Belvoir, VA 22060-5281, telephone (703) 664-3826, AV 354.

School News

Hand-held Calculator:

The Directorate of Combat Developments has recommended that CTA 50-909, *Field and Garrison Furnishings and Equipment,* be changed to allow engineers to requisition the TI-30 SLR solar calculator. Offering more than 50 functions, this calculator should help solve the many mathematical problems associated with typical field engineering tasks.

For more information contact James E. Mason, ATZA-CDO, Fort Belvoir, VA 22060-5281, telephone (703) 664-3502, AV 354.

Defense Mapping School (DMS)

DMA Reviews Survey Support Requirements:

The Defense Mapping Agency is reviewing geodetic survey support requirements. New, user-operated precise positioning devices may eliminate the need for topographic surveyors in the 1990s. The basis for this review is *The Army Position and Navigation Master Plan*, April 1986, which is the Army plan for position and navigation systems.

If these systems meet all geodetic survey support requirements, they will eliminate the topographic surveyor (82D) MOS.

Address your comments to: Director, Defense Mapping School, ATTN: CW3 Besch, Fort Belvoir, VA 22060-5828.

MOS Revisions for 83E and 83F:

Several changes are in store for the topographic engineer career management field. The Deputy Chief of Staff approved two revisions in June 1986.

Photo and layout specialist (83E)—Revisions to this MOS include skill level progression to staff sergeant. A secret security clearance will be required for all skill level 3 personnel.

Photolithographer (83F)—The title photolithographer will change to *printing and bindery specialist.* A secret security clearance will be required for all skill level 3 and 4 personnel.

Both MOSs will have revised duty position titles and standards of grade authorization. Mandatory training will be added.

CMF 81 Streamlined:

An electronic maintenance study recommended the consolidation of MOSs for topographic instrument repair specialist (41B) and fire control instrument repair specialist (41C) to streamline maintenance-specific occupations.

The Engineer School agrees with the concept and expects a final report with approval soon.

Engineer Personnel Proponency Office (EPPO)

EPPO 24-hour Hotline:

The Engineer Personnel Proponency Office now has a 24-hour hotline to answer questions—about structure, acquisition, deployment, sustainment, professional development or separation—that cannot be handled at the installation or MACOM level.

EPPO hotline numbers are: toll free 1-800-336-3095, extension 3646, (703) 664-3646, AV 354.

Regimental System Update:

The goal of the Corps of Engineers in the new regimental system is to enhance combat effectiveness by forming all engineers into one unit characterized by strong bonds of loyalty and commitment. Army Reserve and National Guard engineers are now recognized as part of the Corps, emphasizing the strong kinship between Active and Reserve Components.

To further enhance the unity of the Corps, the Engineer School Brigade was redesignated the 4th Engineer Brigade, honoring the distinguished WWII unit of that name. In a November 7th ceremony, COL George T. LaBlonde turned over command of the brigade to COL Roger C. Strom, formerly Fort Belvoir's Director of Military Logistics.

At the same time, the 1st and 3d Battalions became the 809th and 554th Engineer Battalions, respectively, both also units with historic combat records.

At a ceremony held at Fort Leonard Wood on 28 September 1986, the following engineer units were redesignated: 1st Training Support Brigade became 136th Engineer Brigade; 2d Training Brigade—132d Engineer Brigade; 1st Battalion, 2d Brigade—35th Engineer Battalion; 2d Battalion, 2d Brigade—31st Engineer Battalion; 4th Battalion, 2d Brigade—589th Engineer Battalion; 4th Training Brigade—1st Engineer Brigade; 2d Battalion, 4th Brigade—87th Engineer Battalion; 3d Battalion, 4th Brigade—169th Engineer Battalion; and 4th Battalion, 4th Brigade—577th Engineer Battalion.

Distribution of the new Corps of Engineers crest has been delayed until FY 87 for active and reserve units. AAFES clothing sales stores began stocking these items in November. Ultimately, the crest will be issued to enlisted personnel, but officers and warrant officers must purchase their own. Wearing of the crest is governed by AR 670-1 and is optional for all personnel.

School News

Directorate of Evaluation and Standardization (DOES)

Lessons Learned Message:

The USAES *Quarterly Lessons Learned Message*—containing information from NTC, Team Spirit, Blazing Trails and REFORGER—has replaced the *Task Force Engineer/Combined Arms Package.*

For more information, contact: Commandant, USAES, ATTN: ATZA-ES, Fort Belvoir, VA 22060-5271. POC is CPT Craig Tavani, (703) 664-4172, AV 354.

DOES Staff Changes:

LTC John Carey is the new director of the Directorate of Evaluation and Standardization at the US Army Engineer School.

LTC Otis Williams is the new chief of the Evaluation and Standardization Division, DOES.

Reserve Component Advisory Staff (RCS)

Advice for EOAC Students:

If you are an Army Reserve officer planning to take the Engineer Officer Advanced Course at Fort Belvoir, remember that most Reservists are on TDY status (less than 140 days).

Plan to live off-post. Bring enough money to pay initial expenses. Fort Belvoir is a high-cost area and uses the "lodging plus" system.

More details about this system are in the *Advanced Course Welcome Packet*. Complete your plans at least six weeks early so C Company, 3d Battalion, can send your packet on time.

If you have received your orders but not your packet, call C Company toll free 1-800-336-3095, extension 2184, commercial (703) 664-2184, AV 354.

Directorate of Training and Doctrine (DOTD)

SQT Cancellations:

Changes in doctrine, publications or proponency cause skill qualifications tests to be cancelled. TRADOC has approved the US Army Engineer School's request to cancel the following SQTs for 1987:

52C1-3	Utility equipment repairer
52D1-3	Power generation equipment repairer
52F1-3	Turbine engine driven generator repairer
52X4	Special purpose equipment repairer
62N3	Construction equipment repairer

Soldiers holding these MOSs will take their next SQTs in 1988. Scores from previous tests will be used for personnel management purposes as appropriate.

Department of Military Logistics (DML)

Proponency Moves for 52C, 52D and 52F:

Proponency for MOSs utility equipment repairer (52C), turbine engine driven generator repairer (52F) and power generation equipment repairer (52D) is being transferred from the Engineer School to the Ordnance School. The commanding generals of both schools signed a memorandum of agreement in June 1986.

Proponency, training development, training and apprenticeship will transfer by October 1987. Command and control of troop units will move by October 1988. Training for MOSs 52C, 52D and 52F will continue at the Engineer School until facilities are available at the Ordnance School.

New DML Director:

COL Gerald M. Tippins is the new director of the Department of Military Logistics.

COL Jack E. Weber is the new commander of 809th Engineer Battalion.

The Combat Engineer/ Team

Do combat engineers occupy one turret of the engineer castle and topographic engineers the other? Do they enter the portal and go their separate ways without communicating? Unfortunately, too often the answer is, "Yes."

by COL David F. Maune

A Combat engineers generally believe they alone are responsible for the engineer functions of mobility, countermobility, survivability and general engineering (FMs 5-101 through 5-104). Topographic engineers tend to take sole responsibility for the topographic function (FM 5-105).

In reality, the outcome of future battles depends upon our ability to work together as a team. New doctrine laid out in FM 5-105, *Topographic Operations*, which will be published in FY 87, demands that all engineers become terrain experts. Every combat engineer must be a topographic engineer, just as every topographic engineer must be a combat engineer.

FM 5-105 places topographic engineers squarely at the portal—not only of the engineer castle but of the supported command post—gathering terrain information from and disseminating terrain information to all.

The Army's keystone manual, FM 100-5, *Operations*, recognizes that ***"Weather and terrain have more impact on battle than any other physical factor, including weapons, equipment, or supplies.... Indeed, most battles have been won by the side that used terrain to protect itself and to reinforce fires to destroy the enemy."***

But terrain not only provides opportunities and imposes limitations; engineers can manipulate it—giving a decisive edge to the commander who uses it best.

FM 100-5 stresses that terrain analysis, engineer operations and intelligence preparation of the battlefield are all basic to the commander's operational use of terrain.

The command engineer, normally a combat engineer, is the terrain advisor at each level of command. He helps the commander see the battlefield and use the terrain—two fundamentals of war.

The strength of his expertise depends on how well his combat and topographic engineers understand one another's business and exchange terrain information.

For example, the combat engineer who understands topographic engineering can turn mobility and countermobility planning from artful guesswork into a science with the help of tailored products like the cross-country mobility analysis (story page 27).

At the same time, topographic engineers—who work primarily with space-based sensors, aerial photography and terrain data base libraries—need eyes and ears in the field. They depend upon combat engineers to establish the *ground truth* of their information so confident command decisions can be made.

They need reports on the latest status of minefields, obstacles, rivers, bridges, roads, railroads, ports, harbors, airfields, facilities and utilities. They need assistance to verify and update data bases on surface drainage, soils, vegetation and lines of communication.

All engineer missions require a constant exchange of terrain information between topographic and combat engineers (story page 13).

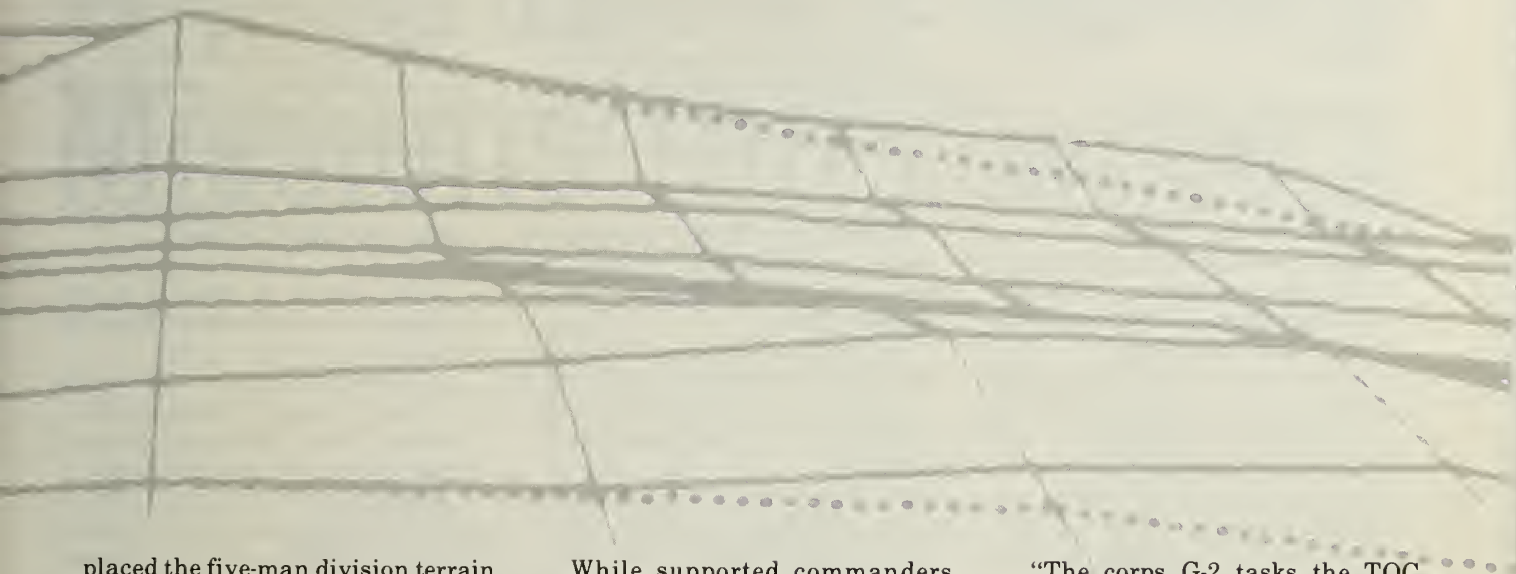
No system currently exists to support that exchange. But FM 5-105 opens the door for change.

New Doctrine

Before 1981, the Army did not routinely have terrain teams in direct support of maneuver divisions, and there were no terrain analysis technicians (warrant officers) as we know them today.

Until now, Army doctrine (FM 5-146, *Engineer Topographic Units*, and FM 21-32, *Topographic Support*)

Topographic Engineer



placed the five-man division terrain team totally under the division G-2 with the "special staff cognizance" of the division engineer.

Most division terrain teams worked in the All Source Intelligence Center of the TOC. While this worked for most of the Army, it had disadvantages for engineers:

- Division engineers and assistant division engineers had little, if anything, to do with division terrain teams. Combat and topographic engineers did not routinely share terrain information because they did not consider themselves to be mutually supporting.
- Division engineers were not necessarily the *terrain experts* they were expected to be. They were, therefore, less effective in recommending optimum ways to reinforce the terrain.
- Division engineers had no direct terrain analysis support to handle topographic responsibilities.
- The organizational structure made it difficult for overworked division terrain teams to request backup support from corps terrain teams or reconnaissance support from divisional engineer battalions.

While supported commanders, G-2s, G-3s and G-4s were generally pleased with their topographic support, the engineer house was not in order. To support AirLand Battle, we needed a more efficient, effective relationship between combat and topographic engineers.

FM 5-105 makes significant departures from the past by clarifying intelligence and engineer staff topographic responsibilities at all levels. The division engineer becomes the division commander's chief terrain advisor.

Intelligence Staff Responsibilities

"From the assistant chief of staff for intelligence at HQDA down through the division G-2, the intelligence officer has general staff responsibility for topography," according to FM 5-105.

"This means the intelligence officer is responsible for topographic policy, solicitation and validation of requirements, and establishment of priorities for topographic support within the command.

"This always includes high priority, continuing terrain analysis support of the intelligence preparation of the battlefield (IPB) process.

"The corps G-2 tasks the TOC support element of the corps terrain team and coordinates other topographic support requirements and priorities with the corps engineer.

"Battalion and brigade S-2s compile and submit topographic requirements and priorities for their commands to their division G-2.

"The G-2 consolidates these requirements with division staff requirements, establishes priorities, coordinates topographic support with the division engineer, and tasks the division terrain team."

Engineer Staff Responsibilities

FM 5-105 gives the engineer officer, from the assistant chief of engineers at HQDA, down through the division level, special staff responsibility for topography.

"This means the engineer officer is recognized as the terrain utilization expert responsible for topographic program execution, training, resourcing and coordinating technical topographic requirements with the staff and subordinate commands," FM 5-105 says.

"Battalion task force and brigade engineers are also terrain experts at their organizational levels.

"All engineers regularly assist in

terrain data collection (such as river, soil, route and bridge classification) to fill data voids and verify data in terrain analysis data bases.

"All engineers also exploit terrain data and analysis in order to focus reconnaissance efforts and otherwise assist in site selection, planning and estimating for performance of mobility, countermobility, survivability, and general engineering missions."

The Division Engineer

Most significantly, the division engineer has new responsibilities to:

- Advise the division commander on effective terrain use.
- Coordinate division topographic support requirements and priorities with the G-2 who tasks the division terrain team.
- Assist the G-2 in evaluating requirements, setting priorities and selecting alternatives.
- Coordinate terrain team deployment in support of the G-2.
- Coordinate support from the corps topographic company through the corps engineer.
- Task engineer units organic to the division to collect terrain data in the field.
- Prepare the topographic operations annex for division CONPLANS/OPLANS/OPORDS in coordination with the G-2, G-3, G-4 and chief of the division terrain team.

FM 5-105 focuses responsibility for topographic engineering in the office of the assistant division engineer where one NCO from the division terrain team will be physically located. The NCO will provide a liaison with the terrain team and assist the division engineer in carrying out his new responsibilities.

The remainder of the division terrain team is normally located with the G-2 staff.

This allows timely support to the division staff and gives the terrain team immediate access to the all source intelligence data that is critical to prepare current products.

It also helps the G-2 and engineer work closely together to satisfy division topographic responsibilities.

A new TOE, which will be implemented in October 1988, increases the staff of the division terrain team from five to eight to meet the growing demand for terrain analysis.

For the new doctrine to succeed, division and assistant division engineers must:

- Become familiar with the capabilities and limitations of topographic units.
- Give high priority to the management of topographic engineer resources and execution of topographic responsibilities.
- Obtain the special security clearances necessary to operate in the all source intelligence arena.

Corps and Above

The only doctrinal changes at corps and above involve the TOEs, which will also be implemented in October 1988.

For unity of command, the new corps TOE merges the corps terrain team as two or more terrain squads within the corps topographic company.

Modular TOEs are being used to tailor engineer topographic organizations at all echelons to the unique requirements of the supported theater.

Reach Out

When combat engineers join forces with topographic engineers to analyze and reinforce the terrain to maximum advantage, everybody wins.

The corps and division engineers are better advisors to their commanders.

The G-2s—responsible for weather, enemy and terrain intelligence—are better able to carry out their intelligence preparation of the battlefield mission.

The G-3s can develop concepts of operation and detailed plans of execution based on accurate terrain information and realistic analyses.

The G-4s can operate with superior knowledge of the capabilities and limitations of transportation networks.

The commander knows his entire staff is coordinating with the best possible terrain information.

Combat engineers, reach out and meet your teammates—the topographic engineers. Together, we can meet the challenges of AirLand Battle. Divided, we repeat past mistakes. Our choice is clear.

COL David F. Maune is the Director of the Defense Mapping School.

His combat engineer assignments included company command at Fort Leonard Wood, MO, and S-3 of a combat engineer group in Korea.

His topographic engineer assignments included company command and S-3 of a topographic engineer battalion in Germany; map and weather officer for HQ, US Army Vietnam; topographic plans officer, OACSI, HQDA; command of a topographic battalion in Hawaii; and inspector general of the Defense Mapping Agency.

COL Maune has a bachelor's degree in mechanical engineering from the University of Missouri at Rolla plus master's and doctorate degrees in geodetic science/photogrammetry from the Ohio State University. He is a graduate of the CGSC and the Naval War College.

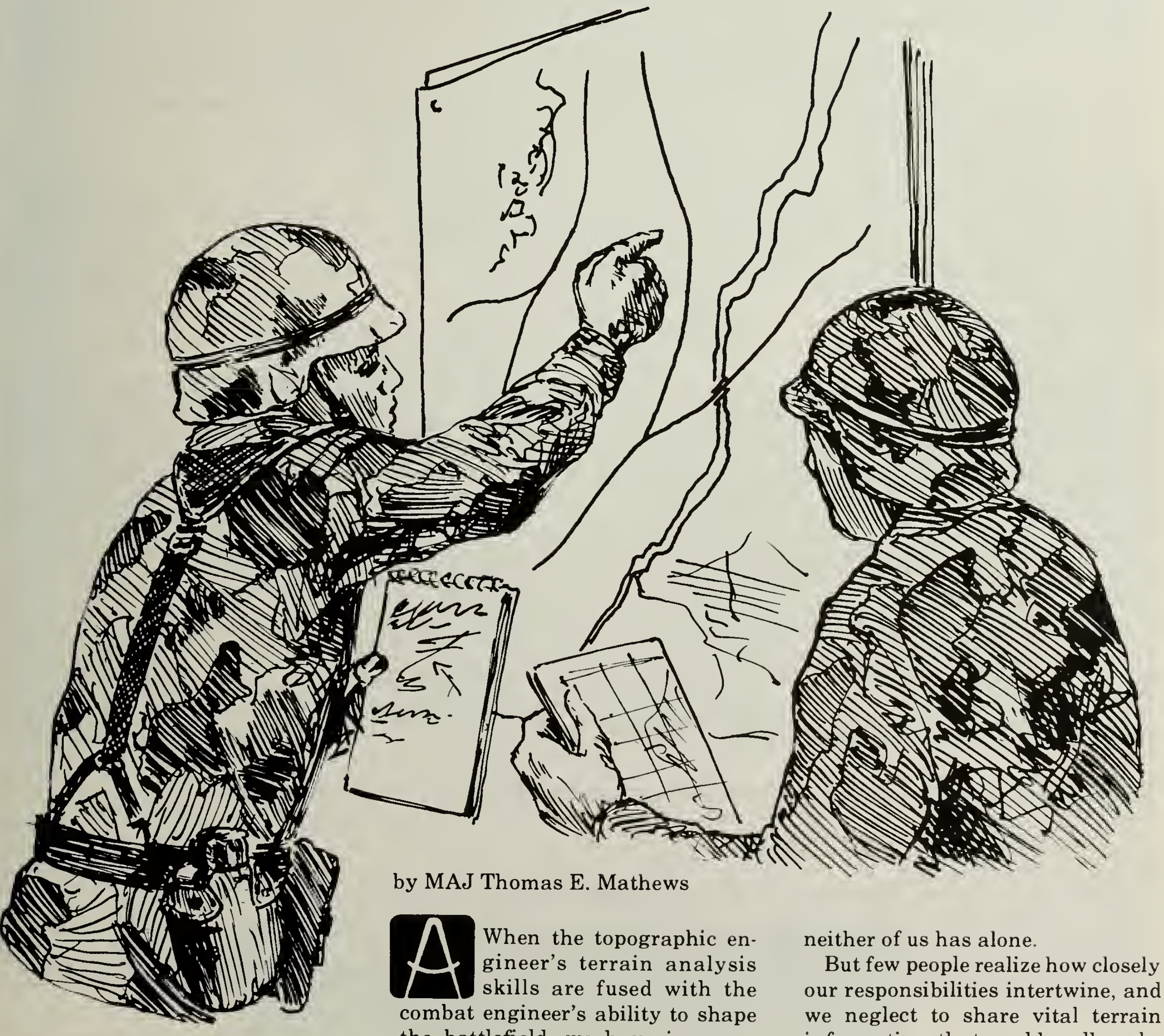
Do you know?

During WWII, topographic support in Europe involved over 7,000 personnel who produced 30 tons or 600,000 maps per day—at a cost of $6 million per month.

Army topographic units produced 40,000 different maps covering 400,000 square miles.

The campaign in Northern Africa required 1,000 different map types—over 10 million actual map sheets. The Normandy Invasion required over 70 million map sheets.

Combat Engineer and Topographic Engineer Missions Intertwine



by MAJ Thomas E. Mathews

A When the topographic engineer's terrain analysis skills are fused with the combat engineer's ability to shape the battlefield, we have immense influence over how the battle will be fought. Together, we give the combined arms team added muscle that neither of us has alone.

But few people realize how closely our responsibilities intertwine, and we neglect to share vital terrain information that could well make the difference between victory or defeat.

Mobility

Combat engineers need to detect enemy minefields and obstacles in order to plan countermine or counterobstacle missions. Topographic engineers can predict likely locations—saving time and focusing the engineer effort. As minefields and obstacles are reported, the topographic engineers can plot the locations and characteristics on map overlays for dissemination.

When a minefield or obstacle is neutralized, engineers must report through the assistant division or corps engineer so the terrain team can annotate the master map overlays for dissemination to others.

To plan a gap or river crossing, combat engineers need details about the river or gap not available on topographic maps. Reconnaissance is warranted if terrain and time permit. The findings should be funneled to the division or corps terrain team.

When reconnaissance isn't possible, combat engineers should check with the terrain team to see whether information on the river or gap is available in the terrain data base (story page 27). Once the gap or river is crossed, combat engineers must share their findings with the terrain team so the master map overlays can be annotated.

Reconnaissance is also preferred when planning construction and repairs of roads, trails or airstrips. But if conditions don't permit, the terrain team may have useful data. Once the roads, trails or airstrips are constructed or repaired, information must again be reported through the assistant division or corps engineer to the terrain team so master overlays can be annotated.

COMBAT ENGINEERS

Countermine or Counterobstacle
*Detect minefields and obstacles
*Plan/estimate
  Neutralize
    Bypass
    Breach
    Clear
  Mark minefields
*Report

Gap Crossing
*Reconnoiter
*Plan/estimate
  Deploy bridging
  Prepare assault site
  Prepare far shore
  Construct/emplace bridging
  Cross
*Report

Combat Roads, Trails and Forward Aviation Combat Engineering (FACE)
*Reconnoiter
*Plan/estimate
  Construct/repair
  Maintain
*Report

TOPOGRAPHIC ENGINEERS

Prepare/Exploit Standard Terrain Factor Overlays
*Surface configuration
*Surface materials
*Surface drainage
*Vegetation
*Obstacles
*Transportation

Prepare/Exploit Tailored Overlays
*Cross-country mobility
  For specified vehicles
  Wet or dry weather
*Avenues of approach
*Landing zones
*Drop zones
*Prediction of enemy minefields and obstacles
*Location of construction materials

Update Topographic Map Information
*Update map information on roads, bridges, airfields
*Update other map features for currency, battle damage
*Depict minefields and obstacles

* Task where terrain information should be exchanged between combat and topographic engineers.

Do you know?

Maps and charts differ in that—

- ***A map is a graphic representation—usually on a plane surface and at an established scale—of the earth's natural and artificial features positioned relative to a coordinate reference system.***
- ***A chart is a special-purpose map, generally designed the terrain team will tailor its answers to your needs.***

Countermobility

Combat engineers normally perform map, ground or aerial reconnaissance to estimate the best locations for emplacing minefields, obstacles and demolitions to deny the enemy mobility.

Topographic engineers can provide cross-country mobility analyses and other tailored products that identify sites with potentially high payoffs (story page 27). They are ideal for obstacle planning, followed by ground reconnaissance to verify the merits of the site. Without them, combat engineers can waste valuable time and still end up guessing.

As countermobility missions are executed, engineers and maneuver units must report them through their division and corps engineers so terrain teams can annotate master map overlays and disseminate the information.

COMBAT ENGINEERS	TOPOGRAPHIC ENGINEERS
Mine Warfare, Obstacle Demolitions or ADMs *Reconnoiter *Select site *Plan/estimate Execute mission *Report	**Reproduce Map Overlays** Same as all of the mobility tasks except mobility models used for cross-country mobility analyses for countermobility tasks are based on characteristics of enemy mechanized and wheeled vehicles.

* Task where terrain information should be exchanged between combat and topographic engineers.

Survivability

Survivability involves camouflage and concealment, as well as construction of fighting, protective and decoy positions. Each requires a reconnaissance, if possible, before planning and estimating.

Terrain teams can tailor products that provide information on cover and concealment, observation and fields of fire, and other information to assist in survivability planning. They should also depict locations of fighting, protective and decoy positions, warehouses, hospitals, tunnels, utilities, food stocks, and POL.

To improve the data base, all new information must be funneled to the terrain team.

COMBAT ENGINEERS	TOPOGRAPHIC ENGINEERS
Fighting, Protective and Decoy Positions *Reconnoiter *Plan/estimate Deploy assets Construct *Report	**Prepare/Exploit Standard Terrain Factor Overlays** *Surface configuration *Surface materials *Vegetation
Camouflage and Concealment *Identify vulnerabilities *Plan/estimate Deploy assets Construct *Report	**Prepare/Exploit Tailored Overlays** *Cover and concealment maps for winter and summer *Concealment potential from horizontal/vertical observation *Observation/fields of fire maps, line of sight for weapons and radar
	Enhance Topographic Map Information *Urban area maps Facilities (warehouses, hospitals, tunnels) Utilities Food stocks POL
	Reproduce Map Overlays

* Task where terrain information should be exchanged between combat and topographic engineers.

Summary

If you feel that combat and topographic engineers have totally different functions, think again. Both have the mission to exploit or reinforce the terrain. Both advise their commanders on how to best use the battlefield terrain. Both require "terrain sense." Both need the best possible terrain information and rely on each other to get it.

The better we understand this concept, the better engineers we are, and the stronger the Army we support.

MAJ Thomas E. Mathews is the Mapping, Charting and Geodesy Doctrine Development Coordinator at the Defense Mapping School. His topographic engineer assignments include command of the Terrain Analysis Detachment supporting III Corps, and Chief of the Terrain Evaluation Division, Defense Mapping School.

His combat engineer assignments include command of panel bridge and mobile assault bridge companies, S-1 of combat heavy and assault bridge battalions, and assistant S-3 of a combat heavy battalion.

MAJ Mathews has bachelor's and master's degrees in physical geography from the University of Michigan. He is a graduate of the Command and General Staff College.

Do you know?

The Defense Mapping Agency (DMA) inventories over 21,000 different 1:50,000 scale topographic maps—a fraction of the line items in the total DMA inventory.

Even so, less than 50 percent of the world's land area has been mapped at a scale of 1:50,000 and only 80 percent at a scale of 1:250,000, according to a U.N. study.

Writer's Guidelines

Do you have any articles, photographs, or artwork to submit to ENGINEER? Here are some tips.

TOPIC: We focus on combat engineering; however, any articles of interest to engineers are welcome. Write in active voice and be as concise as possible. Please give your article a title, too.

LENGTH: Let your subject dictate length; generally, articles should be two to six pages, double spaced.

PHOTOGRAPHS AND ARTWORK: Besides photographs and artwork which supplement articles, photographers and artists should submit any work that may be of interest to engineers. Your photos should be 5 x 7 black and white, glossy. Please include a caption and photo credit. Drawings should be legible, but do not have to be camera ready.

DEPARTMENTS: We are always looking for items for our departments:

- Letters to the Editor.
- Lessons Learned.
- News and Notes.
- Personal Viewpoint.

ENGINEER PROBLEM: Please submit your challenging—but not too hard—Engineer Problems. Problems should be referenced to a manual, but must be original. They should be checked for accuracy and should strengthen combat engineer skills as well.

COVER LETTER: When submitting material to ENGINEER, enclose a cover letter with your name, address, and phone number. Also, please include biographical information such as military and civilian education and past and present assignments.

If you have any questions, please call us.

(703) 664-3082, AV 354.

Topographic Support Around the World

by Penelope Schmitt

Today's topographic mission is evolving downward and forward, moving toward flexibility and specialized services. Units provide field commanders with tailored terrain information; cartographic effort emphasizes command-unique products; decentralized product storage and distribution prevails; and surveyors support positioning and alignment missions.

To meet these new challenges, the topographic battalions are developing programs unique to their missions. Each battalion—the 30th at Fort Belvoir, VA, the 29th in Hawaii, and the 649th in West Germany and the 1203d (NG) in Alabama—reflects its theater environment and the special needs of the commands it serves.

These four battalions can provide every US field commander in the world with flexible, deployable, tailored topographic support on the AirLand battlefield. All you have to do is ask.

The 30th Engineer Battalion

The 30th Engineer Battalion, under the command of the 4th Engineer Brigade, receives peacetime missions from FORSCOM HQ and coordinates wartime planning with Third Army and CENTCOM. These linkages give the 30th an open line of communication throughout the Army.

While its counterparts often operate by deploying special teams to contingency areas, the 30th deploys much of its complement to the area of operations in order to provide full topographic support. Strong in arid area operations, the unit exercises throughout the western and southwestern United States and has taken its specialized skills to Honduras, Egypt and Jordan.

A Test Bed for New Systems—The Topographic Support System (TSS)

The 30th, collocated with the US Army Engineer School, is an ideal test bed for emerging doctrine and equipment. One of the battalion's prime achievements this year is its success in integrating, training and testing the TSS.

In October 1985, the battalion received the TSS, and its soldiers trained on the new equipment. During the post-training phase, the 30th conducted an emergency deployment readiness exercise, performing a full load out and a static load onto C5A aircraft, checking personnel for overseas deployability, and conducting a convoy. Other exercises followed, culminating in a battalion FTX to test the equipment in the field.

By January 1986, the 30th was ready to deploy a fully trained rapid response element for exercise Gallant Knight. On the way, the battalion proved the TSS's excellent roadability and learned the limitations of its air deployability—only two of the system's loaded semitrailer rigs could be airlifted on each C5A transport.

In just four months, the 30th successfully integrated and employed the TSS, deploying effectively and providing a major exercise with cartographic and reproduction support.

The 29th Engineer Battalion

The 29th Engineer Battalion, based in Hawaii, provides topographic support to the Pacific Command. Operating over a vast area, the 29th's flexible force can sustain simultaneous operations in widely separated areas.

The Rapid Mapping Support Team (RMST)

The 29th's rapid mapping support teams provide swift, deployable, topographic support to contingency and wartime operations. The specialized teams field 16 to 20 members with up to four pieces of mission-essential equipment. When deployed, the RMST can support a limited operation or serve with other units to support follow-on echelon forces.

The 29th trains two to four RMSTs each year. Selected soldiers are assigned to an RMST for intensive technical and tactical training. All team members cross-train in each other's MOSs to ensure full coverage of topographic and equipment maintenance skills.

The RMSTs deployed in 1985 and 1986 to the Team Spirit and Ulchi Focus Lens exercises in Korea and the Balik-Samahan exercise in the Philippines. In these and other situations, the RMST program gives tactical commanders forward topographic support and creates a unique training environment for topographic soldiers.

Tailored Topographic Products—The World You Need to See

The special maps produced by the 29th exemplify the made-to-order support commands can expect from all the topographic battalions. As always, DMA's standard products are the maps of first resort. But standard maps can't always do the job. Topographic support can modify existing products or create new ones. They can—

- Change scale.
- Enhance or delete selected material.
- Combine map sheets to center the area of interest.
- Add information.
- Create or enhance a map with photography or intelligence data.
- Create a photobased map.

The 29th has recently worked with a variety of customers to design and produce these tailored products:

Lines Of Communications Designator (LOCD)—The customer needed a graphic index for existing computerized highway and railway data. The resulting map showed all base map features except water in subdued black and overprinted the LOCD information in a highlighted color.

Team Spirit Black Map—Army aviators needed to see map features and flight hazards under blue-green artificial light. The 29th developed and tested four prototypes during Team Spirit 86. These maps reversed the normal use of colors. They were less reflective in the cockpit, more readable under all lighting, and compatible with night vision goggles.

DMZ Flight Map—The customer asked to see authorized flight corridors along the DMZ in Korea. Accurate depiction of these corridors is critical, because aircraft outside them are treated as likely hostiles. Flight information was overprinted in highlighted colors on standard base maps.

Hokkaido Terrain Analysis Maps—The customer needed terrain analysis maps at 1:250,000 scale. Since no DMA standard terrain factor overlays existed for this area, the customer obtained host nation support. A montage of several map sheets formed each base map. To date, two sheets have been produced with overprints showing LOCs, cross-country movement for wheeled vehicles, and concealment. The last two overprints show winter/dry season and summer/wet season conditions.

The ability to visualize the terrain the way you need to see it is vital to the success of your military operation. This sampling of the support the 29th provides the Pacific Command typifies the topographic resources that are yours to exploit.

The 649th Engineer Battalion

The expert in topography for USAREUR is the 649th Engineer Battalion. Headquartered in Schwetzingen, the 649th has subordinate units stationed throughout West Germany. The battalion is mobile throughout Europe, sending elements to locations as diverse as Spain, Italy, Turkey and Holland. Like its counterparts, the 649th provides a wide variety of topographic support services, including standard, nonstandard and quick-response map products.

Intelligence Preparation of the Battlefield (IPB)—REFORGER 1986

One of the fastest-growing aspects of topographic support is terrain analysis. Knowledge of natural and manmade features, weather, and climate conditions can shape military operations. The 649th's seven terrain detachments provide direct IPB support to USAREUR corps and divisions. During the 1986 REFORGER Certain Sentinel exercise, the 526th Engineer Detachment proved the varied—and valuable—potential of terrain analysis. Maneuver restriction maps based on their intensive soil and weather condition analysis—

- Prevented vehicles from miring in soft or wet terrain.
- Protected valuable farmland and populated areas.

The analysis thus contributed immeasurably to a safe exercise. It also reduced the fiscal and political price of Certain Sentinel by avoiding damage to host nation lands and cutting the cost of reparations.

Planning topographic support for REFORGER starts a year before the exercise. For Certain Sentinel, advance production and quick-response support resulted in a distribution of 1.7 million map products—12 maps for every soldier participating in the exercise.

Nonstandard maps supplemented standard topographic, cross-country movement, and road and bridge maps. These were available for issue at all times at corps map supply points.

The diversified 649th keeps pace with the demands of tactical commanders, providing both standard and tailored support that mirrors changing developments on the modern battlefield.

The 1203d Engineer Battalion

Based in Dothan, Alabama, the 1203d Engineer Battalion, Alabama National Guard, provides topographic support both in the U.S. and overseas. Its HQ, cartographic, and survey companies, together with eight terrain analysis teams, offer high-quality topographic services.

The 1203d, like its active Army counterparts, offers both standard and specialized topographic support. For example, the battalion is the primary source of maps and charts for all Reserve, ROTC and National Guard units in the Southeastern United States. In overseas deployment for NATO's topographic exercise, DOMINATE, the battalion has operated map depots under wartime conditions.

The 1203d can also stand up to the active Army battalions in tailored support capability. It is now acquiring the new TSS, and will train on the system in January and February of 1987. Its eight terrain analysis teams supply 8th Division (NG) commanders with special-purpose map products, and team elements have participated in FTXs and CPXs in almost all 50 states. As a provider of timely, tailored map products and terrain analysis, the 1203d exemplifies the high standards of readiness and capability the National Guard maintains.

Penelope Schmitt is the Features Editor for ENGINEER magazine.

The key is teamwork—
Germany to Vietnam

All topographic engineers are in the terrain information business. But terrain information is not generated in a vacuum. Data must come from those who know—combat engineers, infantrymen, aviators and others.

by COL David F. Maune

In the mid-1960s, I spent three years in key assignments with the engineer topographic battalion in Germany. We produced terrain studies specified by FM 30-10, *Military Geographic Intelligence (Terrain).*

These terrain studies included a series of 1:250,000 maps—each with separate map overprints depicting soils, rock types, drainage, vegetation and landforms.

We compiled data from each country before publishing the final study—a 24- x 30-inch confidential book, 1 inch thick. HQ USAREUR directed us to produce these terrain studies. But we never knew if they were needed or used.

Reassigned to Vietnam, I served as the map and weather officer in the G-2 office at HQ, US Army Vietnam. I visited both corps (called field forces in Vietnam), every division and brigade, and several battalions. At each TOC, I asked the G-2s, G-3s, S-2s and S-3s, "Are you satisfied or dissatisfied with your topographic support?"

The answers I received from the two corps were totally opposite.

In one corps, the consensus was that topographic engineers were worthless. In the other corps, the unanimous response was that topographic engineers were force multipliers essential to successful combat operations.

Each corps was supported by an identical organization—one topographic company and one terrain team. I wanted to know what we were doing right in one half of Vietnam and wrong in the other.

In the corps that had taken a dim view of its topographic support, the units were applying FM 30-10 doctrine...much as we had done in Germany. For security reasons, the units burned the 1:250,000 scale terrain studies upon receipt.

Confidential analyses of soils, geology, drainage, vegetation and landforms at any scale were of no use to the combined arms team. The topographic engineers had not talked with their customers to see what they really wanted or needed. The doctrine clearly didn't fit the war in Vietnam...and probably didn't serve the customer in Germany either.

In the corps that considered topographic engineers indispensable, terrain analysts regularly visited the combat units. They explained topographic unit capabilities and limitations and asked their customers what they needed. A team spirit emerged.

The combat units wanted their obsolete 1:50,000 scale maps updated regularly and wanted map overlays or overprints of intelligence and operations information. The combat units provided most of the data based on their reconnaissance, and the topographic engineers tailored products to meet their combat needs.

Here's how the system worked:

Whenever a reconnaissance patrol, task force, aviator or driver found map information to be obsolete, they reported the problem to the G-2s, G-3s, S-2s or S-3s so the map could be updated. This data was funneled to the terrain team, which maintained mylar overlays for every 1:50,000 scale topographic map within the corps' area of responsibility.

I watched terrain analysts brief a reconnaissance team on expedient measurement techniques and specific items to check when on patrol. I saw map overlays with approximate traces of jungle trails not found on standard topographic maps. Annotations showed where bridges had been destroyed or added since the maps were last revised. Some of the annotations depicted enemy intelligence—locations of suspected enemy organizations and road locations with frequent enemy ambushes.

A day or two before a combat operation, the TOC staff visited the terrain team to personally review the overlays and add intelligence and operations information—helicopter landing zones, unit boundary symbols, artillery fire control plans.

The terrain analysts compiled this information so it could be overprinted on 1:50,000 scale topographic maps of the combat area. Then, cartographers drafted the information to make it suitable for reproduction. The map distribution platoon provided several hundred copies of the standard, 5-color topographic maps. The map reproduction platoon used a 6th color to overprint this new intelligence and operations information on the maps.

Just hours before a combat operation began, hundreds of unclassified, overprinted maps were furnished at the tactical scale. The information was so "hot off the press" there was no time for it to fall into enemy hands.

On 24-hour notice, the terrain team and corps topographic company furnished the combat units with indispensable topographic products. These topographic units effectively communicated with their customers and worked with them as a team.

Published doctrine didn't fit, so topographic engineers improvised with astounding results. Although the terrain team performed many tasks normally done by the cartographic platoon of a topographic company, they did what was necessary to contribute to the success of combat operations.

The key was teamwork. The payoff was a terrain data base that could be tapped at a moment's notice. The lesson is clear. If we exchange information habitually in peacetime, we will do it instinctively in war.

COL David F. Maune is Director, Defense Mapping School (DMS), Fort Belvoir, VA.

Defense Mapping Agency Customer Assistance Office

DMA has opened a new customer assistance office to handle inquiries from all users of DMA products and services. Located in the DMA Office of Distribution Services in Washington, DC, the customer assistance office—

- Helps to obtain DMA products and services.
- Provides status reports of current requisitions.
- Explains the availability and use of maps, charts and geodetic products.
- Handles emergency requests for standard DMA products.
- Coordinates DMAODS support to exercises.
- Forwards other questions and requests to appropriate experts.

The customer assistance office is open 0630-1900 Monday through Friday. After duty hours, telephone messages are recorded for action the next business day.

Call the customer assistance office—toll free (800) 826-0342, commercial (301) 227-2495, AV 287.

Defense Mapping Agency Crisis Management Team

DMA has a 24-hour crisis management team equipped with beepers to handle emergency requirements for standard mapping, charting and geodesy products:

- During duty hours, call the customer assistance office—toll free (800) 826-0342, secure 2334, commercial (301) 227-2495, AV 287.
- Outside normal duty hours, call the communications center—commercial (301) 227-2196, AV 287.

The crisis management team also handles requirements for nonstandard mapping, charting and geodesy products beyond the capability of supporting Army topographic units.

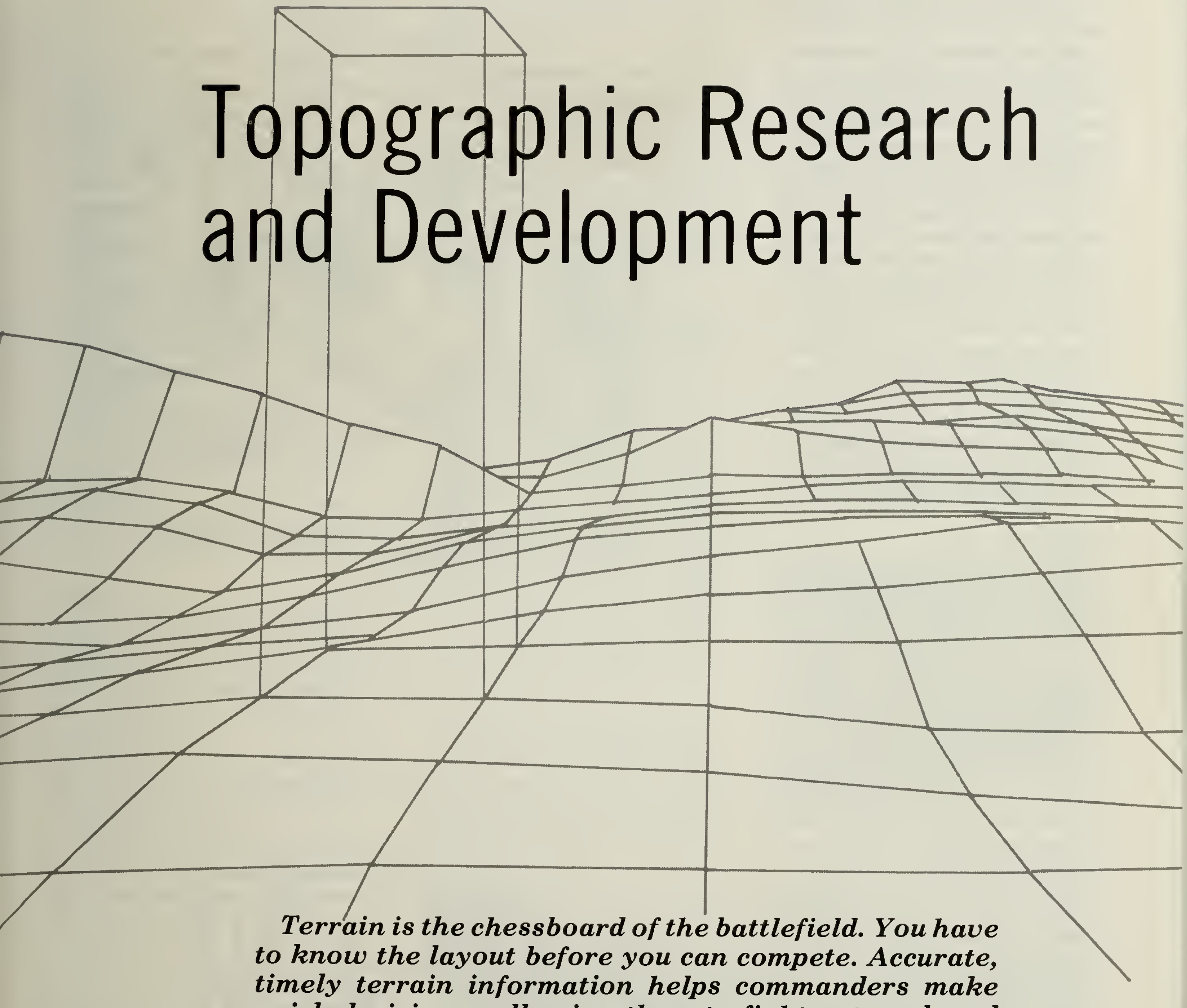
- During duty hours, call the crisis management team—commercial (202) 653-1401, secure 2305, AV 294.
- Outside normal duty hours, call the guard desk—commercial (202) 653-1375, AV 294.

Do you know?

Topographic support for the Army was first recognized on 25 July 1777 when GEN George Washington appointed Robert Erskine "geographer and surveyor of the roads, to take sketches of the country."

"The want of accurate maps has been a grave disadvantage to me. I have in vain endeavored to procure them and have been obliged to make shift with such sketches as I could trace out of my own observations and that of gentlemen around me. I think if gentlemen of known character and probity could be employed in making maps (from actual surveys), it would be of the greatest advantage."

Topographic Research and Development



Terrain is the chessboard of the battlefield. You have to know the layout before you can compete. Accurate, timely terrain information helps commanders make quick decisions—allowing them to fight outnumbered against superior firepower and win.

by COL Alan L. Laubscher and Sandra J. Cleva

A Technology is about to revolutionize battlefield topographic support. During the next decade, commanders will be getting terrain information at unprecedented speeds in new, more useful forms.

Digital topographic data—translating the earth's surface into numbers—already allows military missiles to hit targets with extreme accuracy and lets fighter pilots fine-tune their skills on aircraft simulators without leaving the runway.

New weapons systems—the Pershing II, cruise missile and FIREFINDER counterartillery and countermortar radars—depend on map information that is stored, processed and read by computers.

The Defense Mapping Agency began producing digital topographic data in the 1970s. Although the agency still produces millions of paper maps a year, digital data now accounts for more than half its output.

The agency currently produces two basic types of digital topographic data:

Digital terrain elevation data uses a matrix of uniformly spaced points to describe the shape of the earth's surface—its mountains, hills and valleys in x, y, z coordinates.

Digital feature analysis data describes the characteristics and geographic locations of manmade structures and natural landscape features using a series of x,y coordinates. DFAD depicts point features (towers, single buildings, silos), linear features (roads, rivers, power lines, runways, bridges) and areal features (fields, built-up areas, woods, lakes).

Scientists at the Engineer Topographic Laboratories are now working to bring the digital data revolution to soldiers in the field.

DTSS

The Digital Topographic Support System—scheduled for fielding in 1991—will automate much of the work now involved in terrain analysis. Instead of hardcopy overlays, slide rules and calculators, terrain analysts will use computerized digital topographic data bases.

DTSS will replace the direct support section of the topographic support system and will be mounted on a 5-ton truck. Plans call for one system per division, two per corps and two for echelons above corps.

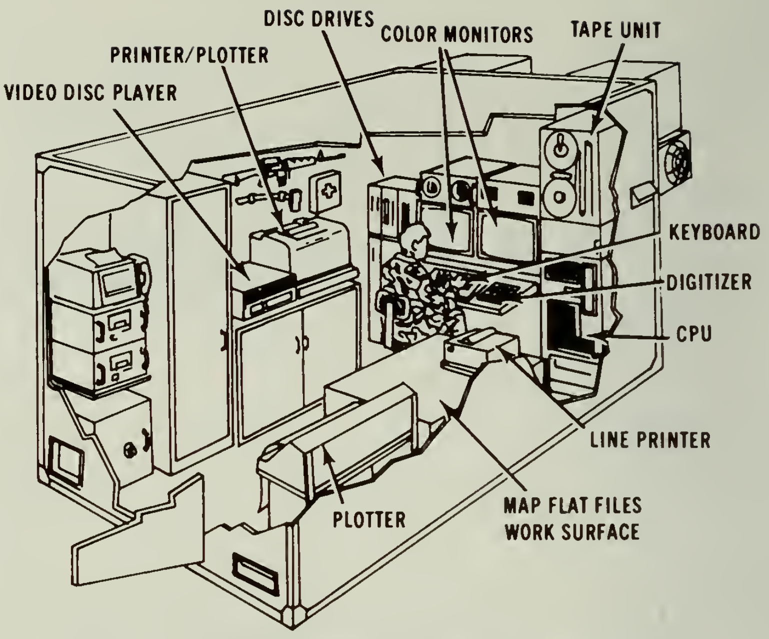
DTSS will give terrain teams access to more than 20 different terrain analysis programs which fall into two categories: ***intervisibility*** and ***mobility.***

Intervisibility analyses use elevation and vegetation data to define areas that can be seen electronically or optically.

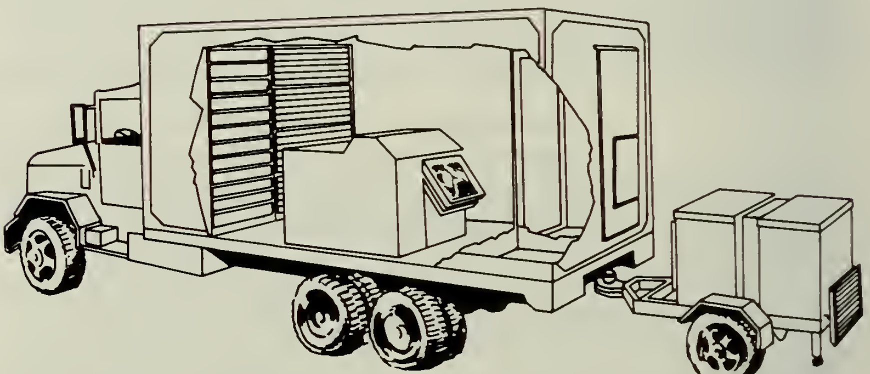
Products include terrain profiles, masked area plots, perspective views, flight line masking graphics, minimum detection altitude computations and oblique projections.

They help commanders determine the best locations for systems by showing the effects of terrain on—

- Weapons performance.
- Communications facilities.
- Short-range radar.
- Other battlefield sensors.



DIGITAL TOPOGRAPHIC SUPPORT SYSTEM (DTSS)



QUICK RESPONSE MULITCOLOR PRINTER (QRMP)

For example, intervisibility analysis plots target acquisition—showing radar's range of coverage for targets approaching at different altitudes.

Mobility products help commanders in deciding where to maneuver men and equipment by—

- Computing the probability of aerial detection for troops and vehicles.
- Examining lines of communication.
- Predicting possible river crossing sites.
- Identifying optimal helicopter landing and drop zones, infiltration routes and air avenues of approach.

For example, the cross-country movement model shows a vehicle's off-road speed capabilities by comparing performance characteristics like climb and override to the slope, soil and vegetation found in the proposed area of operation.

QRMP

The Quick Response Multicolor Printer will soon give the Army fast, combat-oriented reproduction capability—making it easier to copy terrain graphics, maps and other products in the field.

What takes 27 soldiers and ten 30-foot vans full of equipment today will take one soldier and a 20-foot container on a 5-ton truck.

Fielding will begin in 1992. Plans call for two systems at corps and one system per terrain team at echelons above corps, corps and division.

The QRMP uses a dry printing process with a laser scanner. It will cut printing time for field-generated graphics from 8 hours to 5 minutes—turning out 75 multicolor or 225 monochrome copies per hour.

The first printers fielded will reproduce almost any type of hardcopy product—including standard maps, annotated maps, terrain analysis graphics, transparent overlays, photographs and captured enemy documents.

Later, a digital interface will let soldiers print hardcopy products directly from digital terrain data provided by the Defense Mapping Agency or DTSS.

Artificial Intelligence

Scientists are experimenting with artificial intelligence as a way to transfer some of the slow, laborious work involved in interpreting aerial photos from man to machine.

Artificial intelligence allows computers to manipulate symbolic data using informal decision-making rules. Like human specialists, the computers apply inferential reasoning, logic, deduction and a stored knowledge base to interpret information and solve problems.

Two demonstration projects now focus on using artificial intelligence to determine drainage networks and identify urban features like roads and buildings.

Researchers are also evaluating potential uses for terrain data from NASA space platforms and satellite-based sensors. Information from multispectral sensors from NASA's Landsat program is being merged with terrain elevation data from the Defense Mapping Agency to produce three-dimensional perspectives. Future studies will explore ways to generate tactical terrain graphics from multispectral imagery.

Computer Image Generation

Computer image generation—realistic pictures created by combining digital terrain data with information from maps, photographs and satellite imagery—is also on the horizon.

Computer-generated images are already being used for flight simulators and other training devices. The Engineer Topographic Laboratories are exploring possible applications for mission planning and battlefield management.

These images may prove an ideal command and control tool by eliminating much of the interpretation involved in map reading.

Commanders could then see the hills, trees, roads and waterways that make up the battlefield while planning their operation.

COL Alan L. Laubscher commands the Engineer Topographic Laboratories. He served previously as district engineer for the Corps of Engineers Galveston District. He commanded a combat engineer company in Korea and a combat engineer battalion in Germany.

He has a bachelor's degree in industrial engineering from Stanford University and a master's degree in geodetic science from Ohio State. He is a graduate of the CGSC and the Army War College.

Sandra J. Cleva, formerly a public affairs specialist at the Engineer Topographic Laboratories, now works for the Department of the Interior.

Do you know?

DMA produces point positioning data bases used by Army, Navy, Air Force and Marine Corps units equipped with the analytical photogrammetric positioning system to perform hasty point positioning surveys in friendly or enemy territory. System operators for all services are trained at the Defense Mapping School (DMS), Fort Belvoir, VA.

Although some courses are very modern—using satellites to establish accurate positions on the ground—DMS also teaches technology that is hundreds of years old—plane table surveying popular when George Washington was a topographic surveyor.

Terrain Analysis Data Bases-

by CW2 Kathleen Hawes

A Topographic units, especially engineer terrain teams, are in the terrain information business. Every commander, staff officer, soldier and weapons system is a potential customer for our business.

Ask terrain analysts about the terrain or the impact of weather on the terrain, and we give you a professional answer—the best we can in the time available.

If we have a current terrain analysis data base covering the area in question, we can give good answers in minutes or hours. If we don't have the data base, we're all in a heap of trouble; it might take days, weeks or months to collect the raw terrain data needed.

The terrain analysis data base is our library of information from which analyses are prepared to answer specific questions. The data base consists of a series of terrain factor overlays described below.

Terrain Factor Overlays

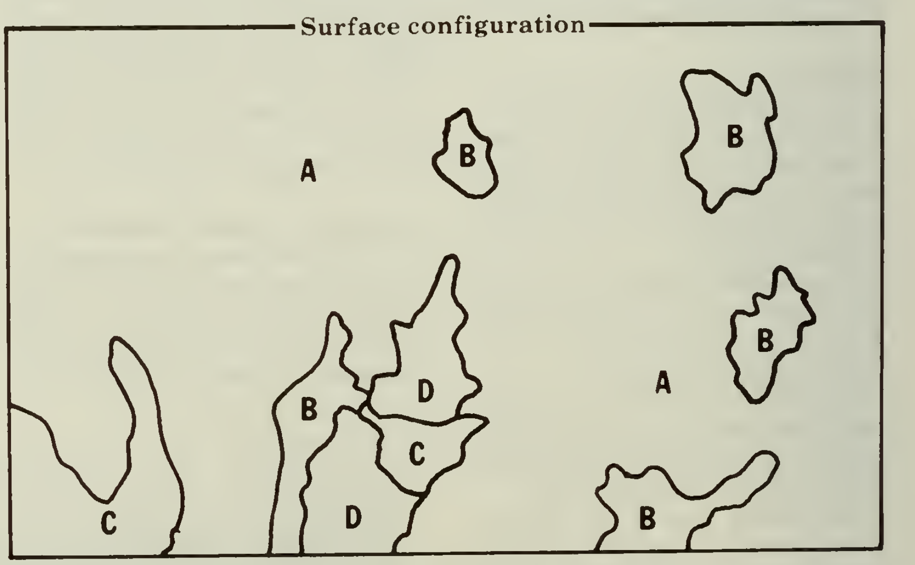
Terrain factor overlays are normally produced by the Defense Mapping Agency (DMA) for use by terrain analysts, but may be produced by engineer terrain teams to DMA specifications.

DMA produces these overlays at two scales—the tactical terrain analysis data base at 1:50,000 scale and the planning terrain analysis data base at 1:250,000 scale.

There are six standard tactical terrain analysis overlays for each 1:50,000 scale topographic map. The data bases for overseas geography are usually classified *confidential* or higher because of their potential value to the enemy. Data bases of the United States are normally unclassified, but are available only for selected training areas.

The ***surface configuration factor overlay*** portrays the maximum slope of the surface at each point on the ground, expressed as percent of slope. Areas are expressed as maximum slope into categories: 0-3 percent (A), 3-10 percent (B), 10-20 percent (C), 20-30 percent (D), 30-45 percent (E), over 45 percent (F) and open water (W).

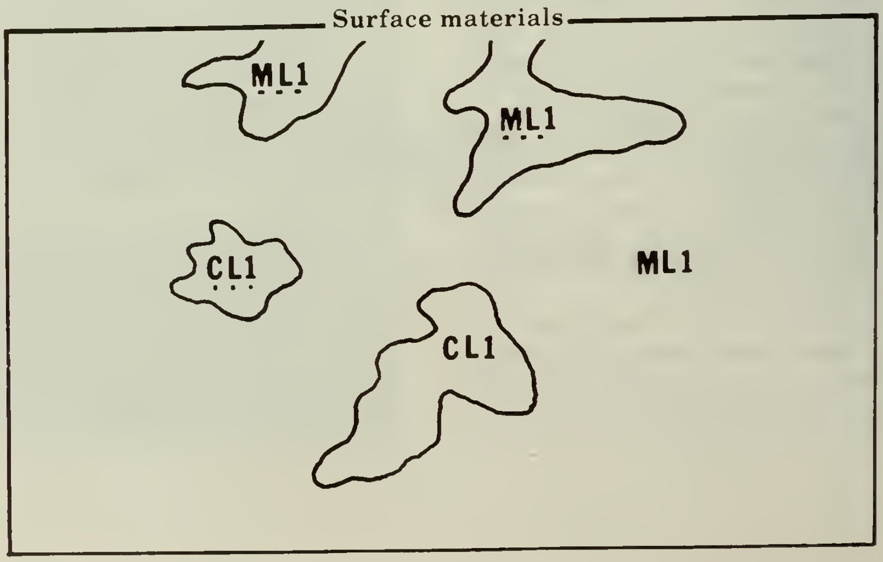
Data from this overlay is normally used only by terrain analysts, but combat engineers could determine locations for roads or airfields with slope limitations—for example, airfields with slopes under 3 percent.



The ***surface materials factor overlay*** portrays the soil on the surface using the categories of the unified soils classification system.

The CL in the example is an inorganic clay, and the ML is an inorganic silt. The third digit indicates surface roughness. Soil categories are further identified by moisture content. Dots underlining the category indicate a moist soil, and dashes indicate a wet soil.

This information is useful for combat engineers when planning construction or repairs of roads, trails and airstrips. This information is vital to terrain analysts performing cross-country trafficability analyses.

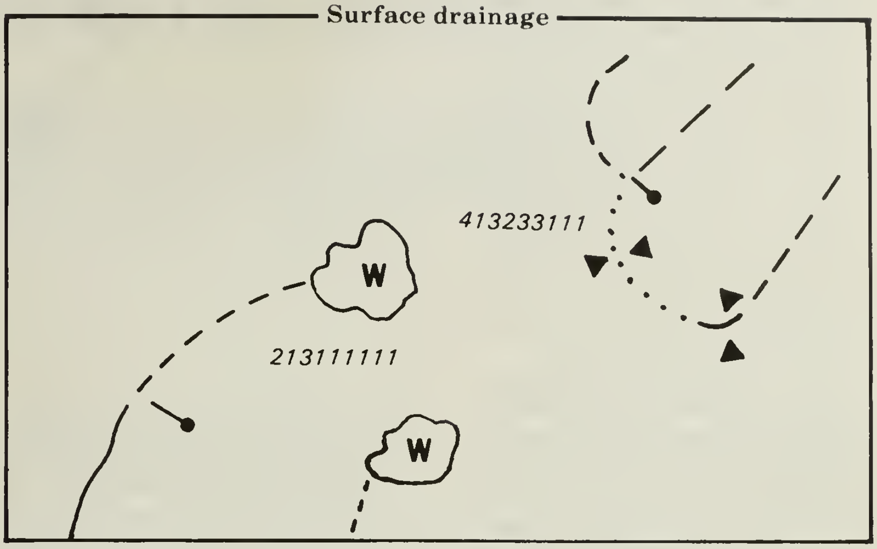


What's in them for YOU?

The ***surface drainage factor overlay*** portrays bodies of water on the earth's surface. Lakes, ponds and reservoirs are depicted as open bodies of water.

Rivers, streams, canals and ditches are defined using a nine-digit code to indicate the type of feature, gap width, bottom materials, height of right and left banks looking downstream, slope of right and left banks, average water velocity, and average water depth. The overlay's legend explains the symbols and nine-digit codes.

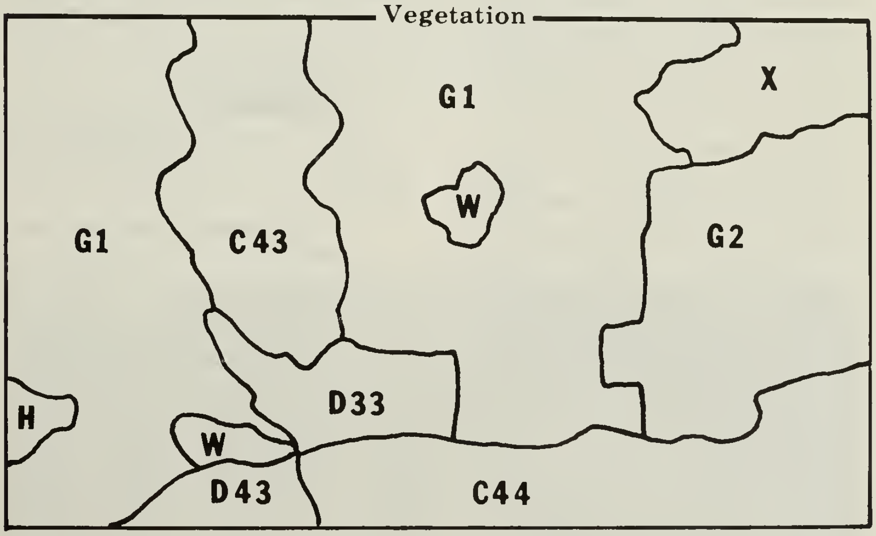
This information is extremely valuable to combat engineers planning river-crossing operations.



The ***vegetation factor overlay*** divides vegetation into categories of tactical significance. Coded letters and numbers indicate types, canopy closure and tree height.

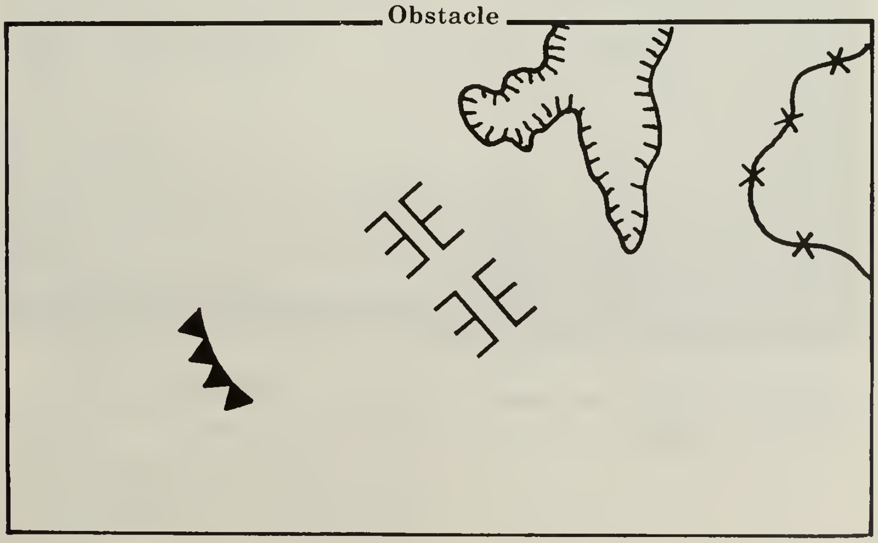
A vegetation factor table provides detailed information on average tree diameter and tree spacing plus the vegetation roughness factor on the forest floor used in trafficability analyses.

The vegetation factor overlay is also used by terrain analysts to calculate line-of-sight and provide cover and concealment information for survivability missions.



The ***obstacles factor overlay*** portrays linear terrain features that form natural obstacles not normally identifiable on a topographic map. All obstacles shown are over 1.5 meters high and longer than 250 meters. Obstacles include road and railroad cuts and fills, escarpments, embankments, depressions, fences and walls, and other microrelief features.

This information is a tremendous benefit to combat engineers making obstacle plans.



The ***transportation factor overlay*** portrays selected roads, bridges, tunnels, ferries, railroads and airfields over which troops and supplies could be moved during military operations.

Information shown on the overlay includes roadway widths; steep grades; length, width, and runway surfaces; and bridge information such as length, width, overhead clearance and bypass potential. A bridge identification number cross-references a bridge data table which gives added information, including construction material, span length and underbridge clearance.

This is important information for combat engineers, G-3s, G-4s and others requiring lines of communication data.

The planning terrain analysis data bases at the smaller scale are similar to the tactical terrain analysis data bases but also include special terrain overlays on water resources for arid areas. These are specifically designed to assist engineers in locating water supplies.

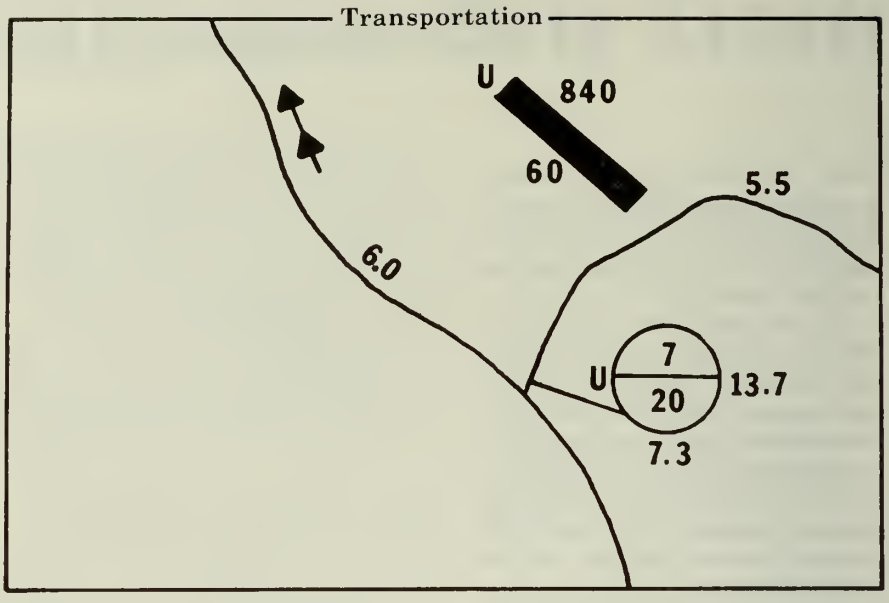
Combat Engineer Input

Combat engineers are uniquely qualified to fill voids in these data bases or to verify the accuracy of the data bases often derived through analyses of aerial photography. With the establishment of ground truth, engineer advice to commanders can be given with far greater confidence.

Combat engineers are well qualified to classify soils, roads, bridges or airfields and provide data for the nine-feature codes for rivers on the surface drainage factor overlays.

All engineers must recognize in peacetime the need for maintaining accurate and up-to-date terrain factor overlays. If and when the Airland Battle begins, we must be ready.

Having our terrain analysis data base complete and ready at all times is the only way engineers can be prepared for war. This is the key to the library which contains answers to the infinite variations of questions that commanders might ask about the terrain on which the battle is planned and fought.



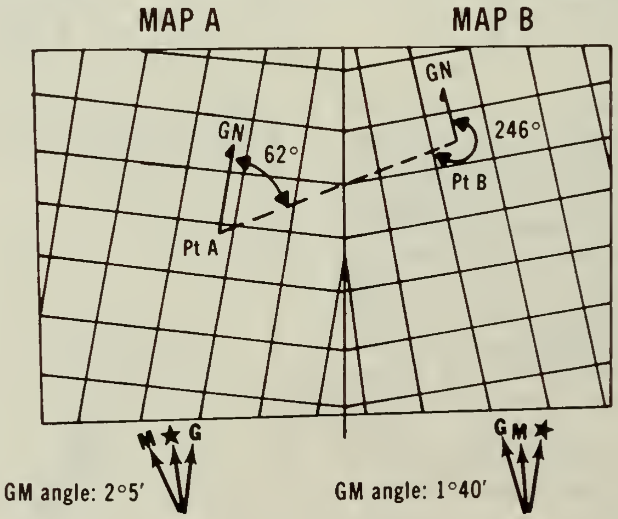
CW2 Kathleen Hawes is the Course Manager for the Basic Terrain Analysis Course at the Defense Mapping School. She has previously served as Chief of the 527th Engineer Detachment (Terrain) serving the 2d Infantry Division. (For three consecutive years, this terrain team was cited as the key to success in the annual Team Spirit exercises in Korea.)

Engineer Problem

Before a field exercise, you carefully tape together two adjacent maps that cover your area of operation. You observe that the grids of the two maps do not line up.

You are planning a night move from point A to point B. At point A, the measured grid azimuth is 62°. At point B, the measured grid azimuth is 246°.

What is the magnetic azimuth from point A to point B?



Engineer Problem/Solution submitted by MAJ Edward Wright, Advanced Technology Division, Defense Mapping School.

Terrain Analysis:
Tailored to the Customer

Did you ever ask a terrain analyst to give you a terrain analysis of the area of operations? That's like asking for an ice cream cone without knowing they come in many flavors.

by CW2 Frederick N. Pessaro, Jr.

A There are hundreds of different kinds of terrain analyses, each designed to answer specific questions from the supported commander or staff. Terrain analyses are normally tailored from information contained on appropriate terrain factor overlays (story page 24), augmented by the latest information available in the All Source Intelligence Center within the TOC.

The combined arms team as a whole needs analyses of the military aspects of terrain known as the OCOKA factors: observation and fields of fire, cover and concealment, obstacles, key terrain, and avenues of approach.

Infantry units are interested in all of these, but airborne units need special drop zone analyses, and airmobile units need landing zone analyses.

Aviation units require analyses of hazards to navigation, especially when flying nap-of-the-earth. They also need information on airfields and support facilities.

Armor units require analyses of cross-country movement. This requires synthesis of several terrain factor overlays (surface configuration, materials and drainage, vegetation, obstacles), mobility characteristics of specified tracked or wheeled vehicles, and current moisture conditions which affect soil trafficability. (Terrain teams in Europe have analyzed these same factors in peacetime to reduce maneuver damage during recent REFORGER exercises.)

Artillery units require choke point analyses to preplan artillery fires.

Engineers need analyses of rivers to plan river crossing operations or forecast floods. They need to locate water in arid regions. They need analyses of soils, geology or timber for construction. They need analyses of roads, bridges, pipelines, airfields, ports, landing beaches and other features affecting movement of supplies. They need many terrain analysis products to support mobility, countermobility, survivability and general engineering site selection, planning and estimating.

Intelligence personnel need a variety of terrain analysis products to support the intelligence preparation of the battlefield. This includes analyses of how the weather affects the terrain for both friendly and enemy forces.

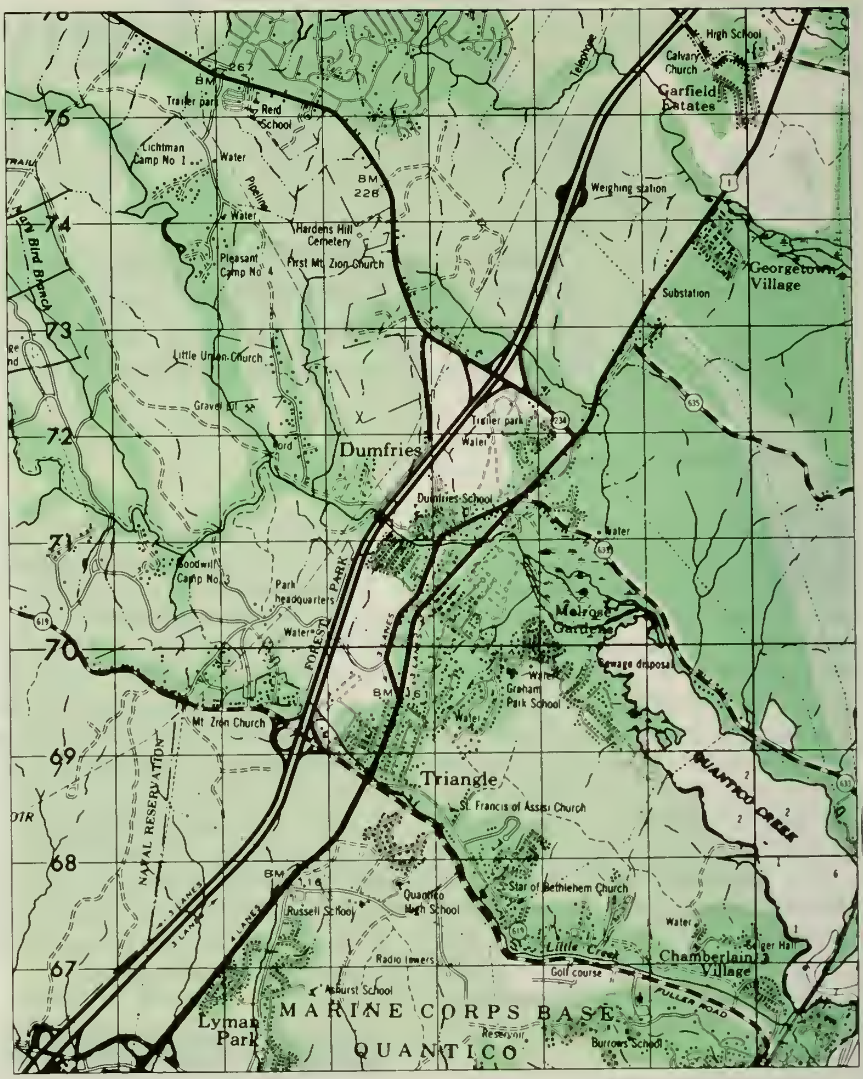
Signal units require analyses of intervisibility for site selection of communication facilities.

Transportation units require analyses of all forms of lines of communications for logistics planning.

Marines may ask for assistance in analyzing the terrain for special

SP4 Rogers, 41D, 588th Engineer Detachment, updates a terrain overlay for Golden Saber XIII.

M-60 tank Cross Country Mobility (CCM) analysis near Quantico, VA. CCM overlays are used by terrain teams in analyzing potential mobility corridors and avenues of approach for specified tactical formations. Best locations for demolitions, minefields or other obstacles are quickly apparent even though such locations are not obvious from topographic map analyses or actual reconnaissance. Such products are frequently classified because of their potential value to the enemy. Time constraints cause such overlays to be normally produced in black and white rather than in color as shown here for demonstration purposes.



☐ GO-AREA >15 KPH

☐ SLOW-GO AREA 1.5-15 KPH

🟩 NO-GO AREA <1.5 KPH

amphibious operations.

Air Force units may ask for help in analyzing natural or man-made terrain features for selection of optimal ordnance to destroy targets.

Terrain teams have been asked to analyze the effects of smoke; fog; rain; fire; and conventional, chemical or nuclear weapons on the terrain.

In high-intensity warfare, the terrain is altered drastically. The terrain analyst must continuously track those battlefield terrain changes and analyze the effects on military operations.

So, the next time you need a terrain analysis, consider the above. If these options don't suit your taste, step right up so we can measure your needs and tailor our products to fit.

Do you know?

We did not have division terrain teams and terrain analysis warrant officers until 1981. The Defense Mapping Agency first received the mission to produce terrain analysis data bases a few years ago.

Since then, engineer terrain teams have had a dramatic influence in helping commanders see the battlefield and use the terrain to maximum advantage.

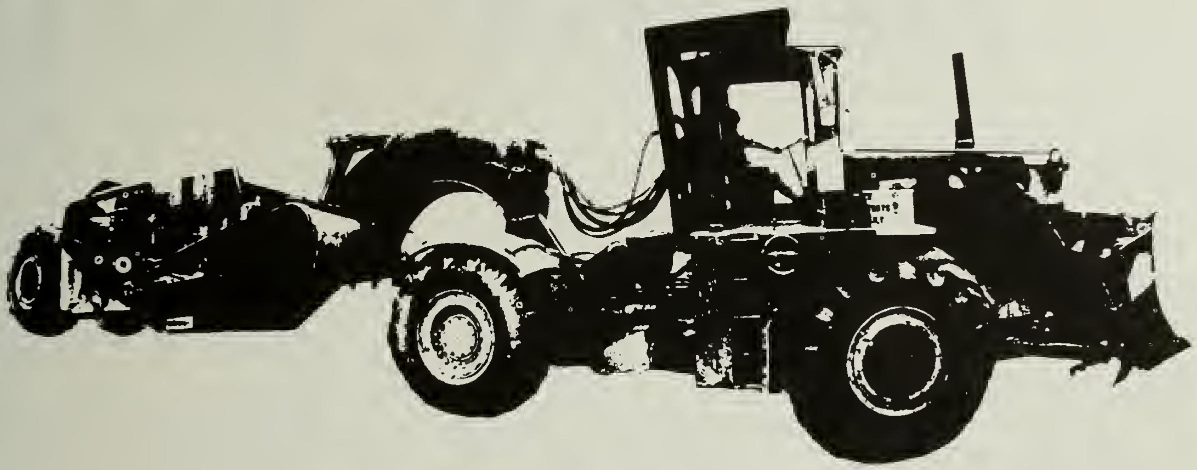
Finally, commanders are using various forms of terrain analyses to analyze the battlefield terrain before preparing the concept of operations.

CW2 Frederick N. Pessaro Jr. is Course Manager of the Advanced Terrain Analysis Course at the Defense Mapping School.

His previous assignments include: Chief, 524th Engineer Detachment (Terrain), 2d Armored Division, Fort Hood, TX; 1SG, 526th Engineer Detachment (Terrain) (VII Corps); and NCOIC, Theater Terrain Team of the 649th Engineer Battalion (Topo) (TA), Schwetzingen, FRG.

Lessons Learned — 621B Scraper

Lessons Learned features thoughts on tactical issues worthy of reflection and professional debate. Many questions have arisen concerning the capabilities and limitations of the 621B scraper, which is replacing the 290M tractor and 830MB scraper. The Engineer School is conducting a survey of 225 units to gather more data. Here are excerpts of comments from the 92d Engineer Battalion (CH), Fort Stewart, GA, based on 16 months of experience with eight scrapers. The views expressed do not necessarily reflect doctrine or policy of the Engineer School.



Issue. What is the 621B supposed to do?
Observations. Earthmoving contractors have used this Caterpillar scraper as their primary earthmover with great success. It is more maneuverable, faster and lighter than either the 830MB scraper or 290M tractor. Extra weight causes both maneuverability problems and soil bearing problems in many types of soil. The 621B lacks the power to pull itself in some soils—but not all. For example, it can often excavate the sandy soils of southern Georgia by the pan alone; however, this is not the most economical way to operate. When a scraper pulls itself, the heat exchanged through the tire causes premature failure. Replacement tires cost $2,600 to $3,000. Some contractors have gone bankrupt by mismanaging this aspect of maintenance.

Issue. The 621B gets stuck, and units spend exorbitant amounts of time recovering it.
Observation. The only reason for this is possibly inexperienced operators. When used with a push cat, this piece of equipment should never get stuck. If stuck, the 621B can be retrieved by any dozer organic to the unit. By comparison, we have seen 290Ms so stuck that, because of their weight, they had to be recovered by a tank retriever.

Issue. The 621B has no bull blade—a loss which has tremendous impact on production.
Observation. Effective use in scraper/push cat operations will help alleviate the problem. A 1:1 ratio of push cats to scrapers is wasteful and unnecessary. There are three primary methods of using a push cat: back-track loading, chain loading and shuttle loading. If these are used wisely, a 3:1 or 4:1 scraper to push cat ratio can be achieved.

Issue. Are there special maintenance or parts problems?
Observation. In 16 months, the only problem not due to normal wear and tear was in the tachometer sending unit, and it was rectified. Parts for Caterpillar equipment are available worldwide—a major advantage over the 830MB and 290M, which were used only by the Army. Since the 621B was fielded at the users' request, some units received it before parts were stocked in the Army inventory. This is not a problem with the equipment—just an example of getting the cart before the horse.

Issue. What about stability or possible blind spots?
Observation. Problems can only be attributed to inexperience. The Army should spend more time and effort training operators. The improved maneuverability of the 621B definitely outweighs any possible blind spots.

Issue. Durability.
Observations. The 621B has proven its durability and reliability, making it popular with earthwork contractors today. The Army has finally broken away from the concept that one piece of equipment can do everything. It has bought a tried and tested piece of name-brand equipment that performs scraping—its primary mission—well.

The POC for Lessons Learned is DOES. The Engineer School wants to hear your training experiences—good and bad—so the lessons learned can be shared with the rest of the force. Write: Commandant, USAES, ATTN: ATZA-ES, Stop 271, Fort Belvoir, VA 22060-5271, or call CPT Craig Tavani, (703) 664-4172, AV 354.

Hey engineer,

make your

BY MAJ Ralph R. D'Elosua

The Blade Effort Triangle, or BET, offers maneuver commanders and supporting engineers a method of agreeing on the blade effort required to support the scheme of maneuver.

The Engineer School teaches the BET as a successful technique for integrating engineer plans with maneuver in combined arms operations, and it has been proposed for the Armor and Infantry schools.

The BET

Simply stated, the triangle (Figure 1) shows the extent to which engineers can support the blade effort priorities first established by the maneuver commander.

The Y-axis initially represents the amount of unconstrained countermobility effort (antitank ditch in meters) the commander wants.

The X-axis represents the unconstrained level of survivability (described in FM 5-103, page 2-6) he desires.

Since the engineer has a limited number of blades to support the operation, there is a direct relationship between the effort available for survivability and the blade effort allocated to countermobility. What's directed toward countermobility is not available for survivability.

Mutual Appreciation

A quick look at the BET while planning his operation shows the maneuver commander the tradeoffs he must make in establishing priorities. There are limits on what can be accomplished given the time and assets available. Once he has a reasonable best guess estimate of the engineer effort required to achieve a goal, he quickly realizes the engineers cannot achieve the impossible.

The BET gives the commander and engineer a framework for discussing priorities, shortfall problems and options. It also gives the engineer an appreciation for the difficult decisions facing the commander.

Simplicity

The beauty of the BET is its simplicity. It can be drawn quickly by virtually anyone. It can be vague (describing only concepts) or specific (showing exact numbers)—whatever is appropriate to the situation.

The BET is of greatest benefit early in the planning process when it can be drawn up to support the unconstrained engineer estimate.

This gives the engineer and his maneuver commander their first glimpse of how extensive the required engineer support will be.

Once the constraints on time and resources are known, the BET is redrawn to show the optimum mix of countermobility and survivability support to be accomplished by "defend time." This gives the engineer and maneuver commander a working agreement.

For example, a brigade with three battalion task forces (two mechanized infantry and one armored) is preparing to defend within 72 hours.

The brigade commander has directed effort to preparation of a counterattack route; overall priorities are to countermobility, survivability and other mobility tasks.

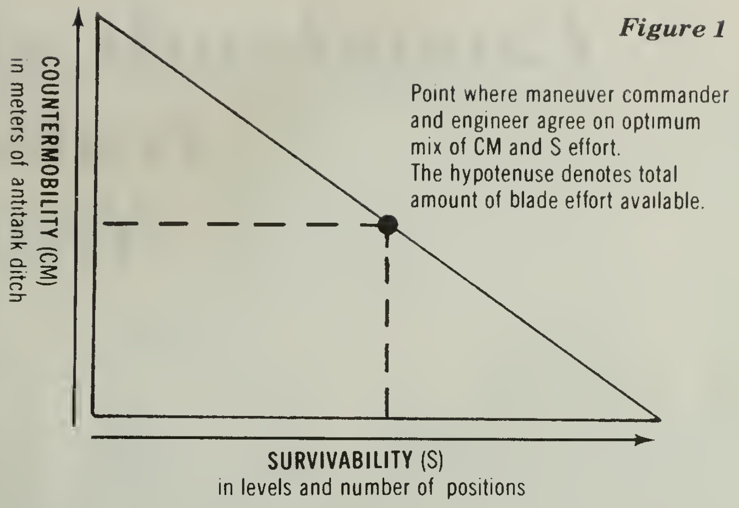
He wants Survivability Level VI with one initial and one subsequent battle position for each task force (see page 2-6 of FM 5-103).

The engineer has 20 blade equivalents within the brigade area for mobility, survivability and countermobility. The directed mobility effort requires 100 hours. (Note: a blade hour is a blade equivalent working for 1 hour.)

After accounting for the effects of travel, maintenance and refueling, he estimates he has 980 blade hours remaining. That's enough time to construct either 33 km of antitank ditch or 1,633 survivability positions

BET!

Figure 1


COUNTERMOBILITY (CM)
in meters of antitank ditch
SURVIVABILITY (S)
in levels and number of positions

Point where maneuver commander and engineer agree on optimum mix of CM and S effort.
The hypotenuse denotes total amount of blade effort available.

or some combination thereof.

Based on the unconstrained engineer estimate, he determines he needs 10 kilometers of antitank ditch to support the countermobility plan. Survivability Level VI for two battle positions per task force requires 1,110 blade hours—unattainable even if all blade assets were directed to the mission.

Given these realities, the question becomes how should the 980 blade hours available be allocated to best support the commander's intent? The BET (Figure 2) helps the engineer show the commander the tradeoffs at a glance.

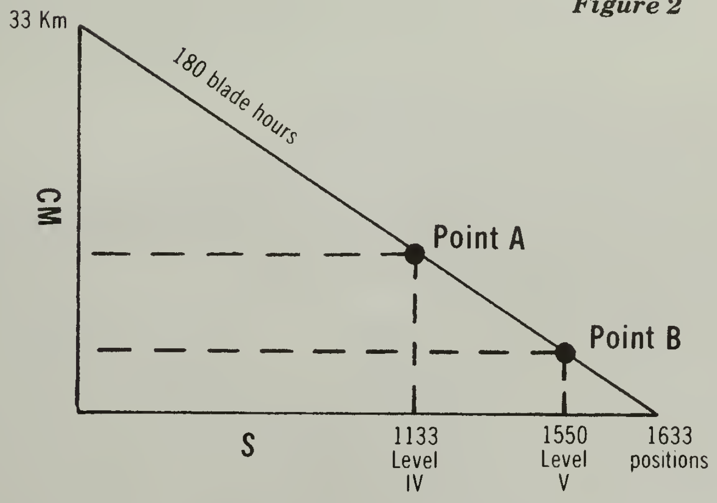
The engineers can carry out the countermobility mission and provide Level IV or 1,133 survivability positions (Point A).

Or the commander can direct Level V for 1,550 battle positions and settle for less antitank ditch (Point B).

During the planning stages for defensive operations, the BET accomplishes several things:

- The maneuver commander and engineer agree early on how to accomplish established priorities realistically.
- The triangle provides a simple picture of how the engineer support is programmed.

Figure 2



- The graph becomes a point of reference for reallocating resources as the situation dictates.
- Planners have a basis for considering alternate countermobility methods such as employing minefields, reinforcing targets or using manpower instead of blades.

Used properly, the BET is a tool for preparing engineer estimates in the defense that greatly enhance the integration of engineers into the maneuver plan.

Engineer, are your ready to make your BET?

MAJ Ralph R. D'Elosua is an infantry officer. He has commanded a BCT unit and an airborne rifle company and served as a battalion S-1 in the 82d Airborne Division. Recently, he was a tactics instructor in the Engineer School. He is a USMA graduate with a master's of science from University of Southern California. He is now attending the CGSC.

Gamelands offer realistic training sites for National Guard engineers

by LTC Charles M. Bechtel

National Guard units that need wide open spaces for training may not have to look farther than their state game lands.

The 876th Engineer Battalion, Pennsylvania National Guard, successfully works with its state game commission to devise annual training projects of mutual benefit to the state and the guard.

Engineers from the 876th Engineer Battalion, Pennsylvania National Guard, cut steel towers into sections before transporting them to a scrap dealer.

For the past two summers, the combat engineers have combined public service engineering projects with a realistic training scenario that included air insertions and OPFOR play. They demonstrated that soldiers can successfully train on state game lands without harming the environment.

Their initial mission—to demolish abandoned steel electrical towers—was part of a project to create landing zones for rotary and fixed wing aircraft. Pilots from the Eastern Army Aviation Training Site practice day and night landings in Bear Valley. The landing zones double as feeding plots for white tail deer.

But the battalion also constructed dirt roads and culverts, replaced unsafe bridges and performed other engineering maintenance for the state.

The chance to operate in 121,500 acres of rugged terrain provided realistic command and control challenges that are impossible to simulate when confined to a 10,000 acre post.

All levels of the command, including platoons and line company squads, had room to operate independently, but in an organized integrated manner as they would in combat.

Three FM radio retransmission stations on key terrain features permitted the commander to communicate over mountain ranges with almost all of the subordinate units.

Helicopters from the Pennsylvania National Guard were used extensively to give the 876th a chance to train with aviators. Helicopters resupplied units located 115 miles and a 3-hour drive from the command post. CH 54 flying cranes delivered 400-gallon water trailers to company sites.

Quartering parties were inserted by air.

UH-1s and LOH-6s helped provide reconnaissance, aerial survey, and command and control during battalion moves. They served as both OPFOR aircraft and friendly aerial covering force during simulated NBC attacks.

The 28th Infantry Division applied constant OPFOR pressure-striking by night and day, harrying soldiers working on construction projects and attempting to penetrate camp perimeters.

Nightly back briefs at the command post helped company commanders immediately analyze their tactical weaknesses and take corrective action.

Thorough coordination with state officials is critical for units who are interested in training on state lands.

The state game commission prepared the environmental impact statements and supporting documentation which set the parameters for the exercise. They provided fire fighting equipment and instructed the guard units on its use.

The state police played an important role—answering questions from people living near the game lands about gunfire and military traffic in the area.

The 876th proved that the National Guard can work closely with government agencies to develop field training exercises that benefit both the community and the soldier.

Other guard units should take stock of their ability to assist states with projects that don't otherwise fit the budget. The engineers' ability to remove unwanted structures, construct irrigation ditches and ponds, build and maintain access roads or conduct a wildlife census is a valuable asset.

When working with state officials remember to—

- Initiate planning and coordination early so environmental concerns are fully addressed.
- Inform the public and all potentially concerned parties on the purpose and extent of the operation. Emphasize the community benefit.
- Use the news media to explain the exercise and create a positive attitude before the exercise starts.
- Request additional equipment like transmission sets well in advance and check everything thoroughly before you need it at the site.
- Plan alternative transportation anytime aviation is the primary means for delivering critical supplies such as Class I items.
- Recognize local officials in the media with letters and awards. You may need their support again.

LTC Charles M. Bechtel commands the 876th Engineer Battalion. He is the state maintenance officer of the Pennsylvania Army National Guard at Fort Indiantown Gap. He is a graduate of the Command and General Staff College and holds an MBA from Penn State University.

Antique shop find...
...Timeless Values

by CPT Joseph J. Miano

I found a treasure in an antique shop in New Orleans last year. For $3.00, I purchased Ralph E. Brown's copy of **The Officers' Guide,** printed in 1939.

Ralph Brown was an officer in the Coastal Artillery Corps. He stamped his nameplate inside the cover as a first lieutenant in the 202d Coast Artillery and updated it faithfully as he progressed to the rank of major in the 5th HQ, Special Troops, 4th Army at Camp Swift, TX.

Within the well-thumbed pages of MAJ Brown's book, I found nine yellowed, handwritten pages of notes for a speech he apparently gave newly commissioned officers during World War II.

The Officer's Guide that served as the foundation for MAJ Brown's talk is one of those small lessons in history we so often forget—a reminder that the roots of today's policies and procedures are in our past.

Much has changed; yet much remains the same. Values are a timeless standard of shared beliefs—a cement that binds the aggregate members of the Army together. I was struck by how true MAJ Brown's message rings 40 years later...by how clearly the attitudes and traditions he sought to foster are engrained in our heritage.

I thought about trying to find out more about MAJ Brown...who he was...what he did...and I'm still curious. But in the end, I wanted to share his thoughts unencumbered as I found them. His words, stand alone. They need no biographic footnote to justify them.

Here are some excerpts of MAJ Brown's lecture notes some 40 years ago:

> *Stand on your own feet. Your seniors are interested in your past only insofar as it may indicate your future worth. The fact that you are well educated, that you spring from a famous family, or that you bear a fine reputation from prior work are all matters of small concern to your superiors. They are interested in how well you execute the tasks of today, so they can better estimate how well you may function tomorrow.*
>
> *Most of us are men of ordinary capacity. Whenever an officer gets a secret suspicion that he is something more than an ordinary mortal, he is likely, unintentionally, to disclose his belief to others. The big fall is then not far distant. Ambition is normal and healthy, if wisely controlled. Officers, like other men in this "Land of the Free," are sometimes prone to take advantage of the freedom of speech. I refer to the habit of sneering, carping, grumbling and criticizing those who are above us.*
>
> *The man who is anybody and who does anything is surely going to be criticized, vilified and misunderstood. This is part of the penalty for greatness; and every man understands it, and understands, too, that it is not proof of greatness. The final proof of greatness lies in being able to endure contumely without resentment.*

Mind your own business. Do this, or if for any reason you should prefer not to, then take your choice of these: get out or get in line.

You must do one or the other—make your choice. If you work for a man, in heaven's name, work for him! If he pays the wages that supply your bread and butter, work for him...speak well of him...stand by him ...and stand by the institution he represents.

If put to the pinch, an ounce of loyalty is worth a pound of cleverness.

If you must vilify, condemn and disparage, resign your position; and when you are outside, damn to your heart's content.

But so long as you are part of an institution, do not condemn it. Not that you will injure the institution. But when you disparage it, you disparage yourself.

You cannot help the **Old Man** *as long as you are explaining in undertone and whisper, by gesture and suggestions, by thought and mental attitude, that he is a curmudgeon and his system dead wrong. You are not menacing him by stirring up discontent and warming envy into strife, but you are doing this...you are getting yourself upon a well-greased chute that will give you a quick ride down and out.*

Avoid thoughtless remarks. Once, in a large building on the East Coast, an officer was standing at a window gazing off over the city. An associate asked what interested him so profoundly.

"I was contemplating the damage we do ourselves by idle conversation. A year ago, I told a friend that sometime I would like to be stationed on the West Coast.

"Recently, my friend has been on duty where he has something to do with assignments. This morning I received a letter telling how happy he was to obtain my orders for the far west. I am to leave at once because of a casual remark made a year ago. I shall have to go to a distant station, far removed from the part of the country it is now in my great interest to remain."

All this is intended to emphasize the importance of avoiding those thoughtless remarks which may cause reaction counter to your intentions and, in the extreme case, may even create the impression of disloyalty.

You do mean to be loyal. Let no person have any doubt about it whatever. Disloyalty is a garment difficult to shed.

CPT Joseph J. Miano is a transportation officer assigned to the Department of Combined Arms, USAES. He served as the S-2 for the 78th Engineer Battalion and the S-3 for the 2d Movements Region, both in Germany. CPT Miano is a graduate of the Engineer Officer Advanced Course and the Transportation Officer Advanced Course. He has a degree in English from the University of Virginia.

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Personal computers at work in the battalion

by MAJ Robert R. McLaughlin

The 3d Battalion, Engineer School Brigade at Fort Belvoir, has successfully automated all aspects of its daily administration from training to duty rosters.

Thanks to a personal computer, the battalion commander and his first sergeant are no longer desk bound.

It handles many of the mundane operational burdens, freeing the staff to manage troops rather than administer records.

The battalion is responsible for command and control of more than 1,000 permanent personnel and 2,000 student officers and NCOs annually. It has two garrison companies of approximately 500 persons each and four student companies or detachments.

Before automation, managing a 500-man company with an authorized staff of two officers and two NCOs was a nightmare. The APRT cards alone required two file drawers.

The first step was to collect all the forms (from the suspense snowflake to the APRT card) and examine how they were used. Each had been maintained as a separate data base in its own unique file. If someone wanted a composite picture, he had to hand sort through piles of cards to collate the data.

The logical question was, "Why can't we use data base management software to do this on a microcomputer?"

Conceptually, a battalion system should encompass the functions of the S-1, S-2, S-3 and S-4. The company should feed the battalion data base and the battalion should feed brigade. Floppy discs can be used to transfer data from company to battalion.

Security is important. The automated data processing security experts on post must accredit the system.

The 3d Battalion's system works on an IBM PC using dBase III. The software includes a tutorial package that helps managers set up data bases and develop their own program applications. The battalion created electronic versions of the standard forms and developed programs so the computer will simultaneously update all appropriate forms.

If, for example, a soldier fails the APRT, the computer calculates his score and annotates his APRT form. It also compares his weight against the screening table weight (AR 600-9). If the soldier is overweight, it annotates his reenlistment card. The computer also reminds managers to schedule a medical evaluation and enroll the soldier in remedial PT and an overweight program if doctors verify the problem.

If the company commander wants to counsel the soldier, the reenlistment card, personal data card and quality point average can be called up at the touch of a button.

For the first time, the 3d Battalion commander has an instant handle on the status of all personnel in two large companies. He can get up-to-date reports on any functional area in minutes. The battalion uses the unit reports and has established a check and balance on the SIDPERS data base. The staff generates SIDPERS reports, compares them to company reports and resolves differences.

One of the biggest benefits is the ability to link the computer to a video projector. Charts and graphs on the computer can be projected on the big screen and edited during briefing rehearsals. Changes can be made on the spot if the boss has a better idea, if data changes or if mistakes were made. It now takes four hours to prepare the battalion's quarterly review and analysis instead of two weeks.

Automated duty rosters are another time saver. Each unit maintains 10 to 15 duty rosters. The clerk who used to spend two hours manually producing a duty roster for 60 people now spends five minutes. The computer completes the job in 45 minutes while the clerk performs other duties in the orderly room.

Computers are not a panacea for all that ails a battalion. Electronic forms aren't a complete substitute for the official hard copy forms and files. But they make it possible to keep accurate, up-to-date records and analyze data.

MAJ Robert R. McLaughlin now serves with the DCSOPS/G-3, US Army, Japan. He was previously the executive officer of the 3d Battalion, Engineer School Brigade, Fort Belvoir. He is a graduate of the USMA and the CGSC. He has a master's degree in engineering management.

Mobile soil labs:
Immediate quality control

by PFC Eric W. Cramer

Getting accurate, timely soils, asphalt and concrete testing is a major problem engineers face when working on road or airfield construction. Poor or insufficient quality control results in construction delays and limits the engineer's ability to make sound decisions in the field.

Part of the problem is that materials testing labs are usually located at the command post miles from the construction site. Quality control testing takes only a short time. But transporting samples to the lab and results to the field takes much longer...while expensive equipment and work crews are left waiting. This often encourages builders to cut corners by not taking the time to do proper testing.

The 802d Engineer Battalion solved this problem by building a mobile soils lab. The lab is equipped for everything from the simplest sieve analysis to asphalt Marshall testing and concrete strength tests. Working directly with the construction crews, the specialists provide on-the-spot quality control without expensive lost time.

SSG Kevin McCarn and SP5 Robert Warner helped develop one of the first such labs while serving in Korea with the 802d.

The mobile soils lab received a thorough workout during its first five days. Operations performed in the field included—

- Sieve analysis.
- Hydrometer analysis.
- Specific gravity test.
- Compaction test (CE55).
- Moisture content test.
- Density determination.
- California Bearing Ratio test (CBR).
- Field identification.

Having the lab at the construction site saved four days for each test, according to SSG McCarn. Quality control specialists performed tests while surveyors compiled all the survey information needed. No one had to leave the site until all important data for both soils and survey had been obtained.

A materials specialist with the 802d Engineer Battalion in Korea weighs a soil sample for sieve analysis. On the spot soils testing makes engineers faster and more efficient in the field.

Easy access to samples for testing was another advantage. "If we needed another sample to get clear results, all we had to do was step out the back door," SSG McCarn said.

A 2.5-ton shop van can easily be converted to a mobile soils lab with the following test kits:

- Soils, NSN 6635-00-641-3643.
- Asphalt, NSN 6635-00-641-3462.
- Concrete, NSN 6635-00-641-4361.

Four pieces of testing equipment must be bolted down—the concrete beam breaker, the concrete cylinder breaker, the Rotorex for asphalt analysis and the sieve shaker. You may have to attach angle irons to the sides of the concrete cylinder breaker to bolt it down. Remember, this equipment is heavy, so distribute its weight carefully.

The rest of the construction is straightforward carpentry. Plan shelving and cabinets in the shop van to best suit the needs of your unit and still permit access to the power bands in the sides of the van.

The mobile soils lab decreases delays and increases the engineers' ability to make sound decisions in the field. It is an idea whose time has come.

For more information on constructing a mobile soils lab for your unit, contact Jeffery Vernon, DME, Roads and Airfields Branch, US Army Engineer School, Fort Belvoir, VA 22060-5335. His telephone number is (703) 664-3075, AV 354.

PFC Eric W. Cramer is the associate editor of ENGINEER.

Maintenance Certification

by CPT Thomas P. Bostick

A surgeon cannot operate without being professionally certified. Plumbers, mechanics and masons must serve apprenticeships to do their jobs.

In the Army, however, it is not uncommon for junior officers and NCOs to have responsibility for equipment they have little chance to learn about. This makes maintenance a difficult area to manage. Many junior officers and first line supervisors lack sufficient knowledge to supervise correctly.

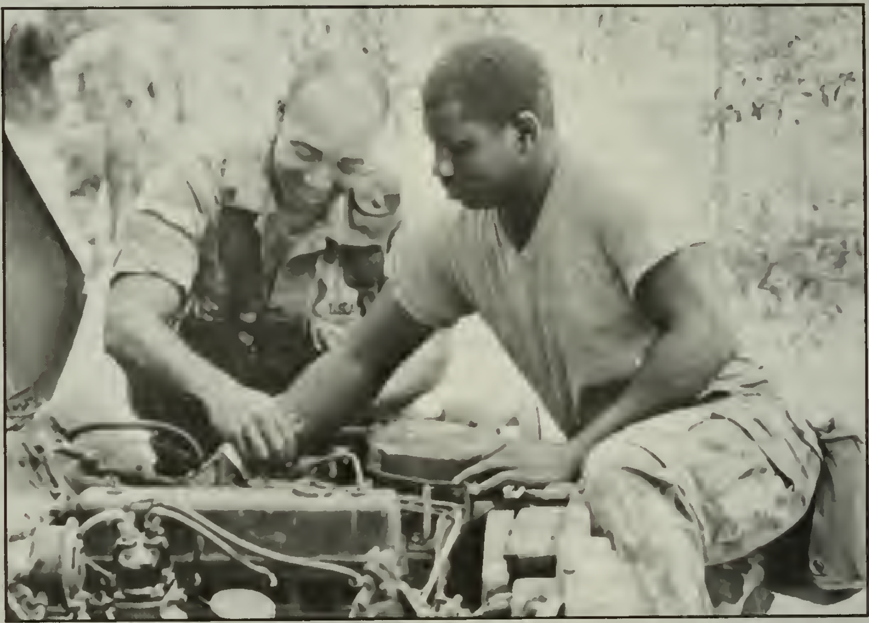
To combat this problem, our commander, LTC Daniel W. Christman, developed a maintenance certification program for new supervisors. This program helped our unit, B Company, 54th Engineer Battalion, win the 1983 Army Chief of Staff's award for maintenance excellence—given to the company with the best maintenance program in the Army.

Our maintenance certification program ensures that new supervisors are competent in maintenance and aware of problems often overlooked by equipment operators. For instance, the program teaches new supervisors the answers to specific maintenance questions such as—

- If the brake system begins to leak, which fitting is most likely the problem based on past experiences?
- On a specific piece of equipment, which engine mounting bolts generally loosen first?
- Where on the vehicle frame should I look for cracks?

The certification program prepares the supervisor to quickly and accurately inspect the equipment.

The actual operation of this maintenance program is simple. Training starts at the platoon level. New personnel are trained by platoon leaders in the company equipment shed. The maintenance sergeant or platoon leader demonstrates the standard daily performance checks described in the operator's maintenance manual. Then the instructor explains problems typical to the equipment in the unit.



Reservist light vehicle mechanics SGT Spencer Jones and SP4 Darryl Mortimer inspect a carburetor. Maintenance certification results in superior performance on maintenance inspections (Photo: CPT Gregory Taylor).

The new supervisor gets both a general overview of maintenance problems and a working knowledge of day-to-day maintenance problems with the unit's equipment.

The certification is complete when the new supervisor passes his written and hands-on examinations developed by the battalion maintenance officer. Officers are tested by the battalion maintenance officer; NCOs receive their training from the company commander. The maintenance certification program instills the self-confidence and ability that comes from demonstrated performance.

It also keeps maintenance supervisors abreast of ongoing problems. Best of all, new maintenance supervisors no longer have to learn their business by trial and error. The maintenance certification program not only helps on inspections but also acts as a confidence builder for maintenance supervisors and as a means for units' trainers to evaluate the quality of their training.

Maintenance certification provides leaders with the technical competence to supervise vehicle and equipment operators to keep our forces ready for battle.

CPT Thomas P. Bostick is an instructor in the Department of Mechanics, USMA. In 1983 he served as company commander of B Company, 54th Engineer Battalion, Wildflecken, Germany, a combat engineer company which won the Army Chief of Staff award for maintenance excellence.

CPT Bostick has master's degrees in both civil and mechanical engineering from Stanford University.

EOAC

Making the Army's best *better!*

By MAJ Randy R. Rapp

The Engineer School improved the Engineer Officers Advanced Course this summer. The changes derived from comments from EOAC graduates and suggestions from last year's Engineer Commanders Training Conference.

New ideas and constructive criticism from students, the field and the faculty have made EOAC the TRADOC model for all officer advanced courses.

Improvements make officers more responsible for their education and allocate time more efficiently. The course now places students in the team room, at the computer terminal, at home studying or at the library researching more than before. The improved course is still based on the seven pillars of EOAC.

Irreconcilable demands on student time have been eliminated, but the course schedule remains challenging. A typical day finds officers in class from 0700-1500 and at PT from 1500-1630. Homework still consumes most evenings and some weekends.

However, to make students' schedules less hectic—

- The course now sets aside 11 Wednesday afternoons for student appointments.
- Post support activities come to the School during a duty day to service students' needs.
- Many afternoons during the last four weeks students can attend to personal affairs.

Small groups—facilitated by team leaders—now last for 16 weeks. This adds small group instruction to the *Base Camps and Contingencies* and the *Operations Officer* modules. Students do scheduled physical training during this period and also retain their team rooms.

Communicative arts—with many improvements—remain a vital component of EOAC. Each of the first six modules includes one graded writing assignment. The course will

Comparison of student hours

	Class 1-85 (October 84)	**Class 7-86** (June 86)
Lecture	329.5	259.5
Non-lecture*	406.5	523.5
Homework	165	179
Total	901	962

**Includes small group exercises, computer assisted instruction, guest speakers, case studies and programmed instruction.*

The seven pillars of EOAC

1. **Total fitness** — develops the student's mind, body and warrior spirit to increase his and his unit's potential.
2. **Small group** — focus on learning from experience and encourages the open exchange of ideas among students.
3. **Computer assisted instruction** — encourages the students to tailor their own instruction by completing automated lessons at their own pace.
4. **Integration** — reinforces learning by requiring students to incorporate concepts and skills from previous lessons into their current instruction.
5. **Team leader** — teaches total fitness and leadership, facilitates tactics and engineering training, evaluates student performance and potential, serves as a professional role model, and provides unity to the instruction of the course.
6. **Scenario** — hinges instruction on a framework of real world problems and conditions.
7. **Challenge/reward** — stimulates individual excellence in academic and leadership skills and promotes team excellence in collective and cohesive performance.

soon use a new TRADOC writing program. Instruction in briefing techniques is more structured than before.

Other improvements include—

Combined arms tactics/combat engineering. Eliminating the *One-Day War Game* allows time for new modules in *Engineer Support of Light Infantry and Special Operations* and *Heavy Battalion Task Force in the Attack* plus expansion of older lessons. Engineers learn to "talk tactics" with the perspectives of maneuver officers.

Technical engineering. A revised scenario makes students thoroughly address tactical considerations in their construction plans. As a result of lessons learned in Germany and Central America, more time is devoted to drainage and concrete construction. Nonstandard fixed bridging is completely revised and consolidated into three days of instruction. Training in POL pipelines is reduced.

Senior team advisor program. A senior engineer officer stationed at or near Fort Belvoir voluntarily associates with a team, critiquing their solutions to tactical and engineering exercises. The mature officer's involvement is limited only by his schedule and his desire to help teach young engineers.

Optional military studies program. Especially dedicated students voluntarily study military history, advanced tactics or professional values during free afternoons, with the guidance of a senior faculty member. Six seminars in each of these topics lend structure to off-duty efforts many students make to improve their professional competence.

Professional development day. Teams visit a military activity or battlefield of their choice. Conducted the last day the teams are together, this exercise gives the team leader a final shot at reinforcing course objectives.

Research paper presentation program. Instead of oral book reviews, students deliver formal classes about the results of research for their papers. The program exposes the teams to less familiar military subjects.

These improvements in the EOAC stem from the Engineer School's strong desire to provide the best captains' training possible. The infusion of new ideas from students, the field, and faculty makes the course the best it can be.

The improved EOAC better accomplishes its mission—to train battle winners.

MAJ Randy R. Rapp was the Senior Team Leader for the EOAC. He served in the 293d, 94th and 326th Engineer Battalions.

MAJ Rapp has a bachelor's degree from the USMA and a master's degree in civil engineering from the University of Missouri/Rolla. He is a licensed professional engineer in Virginia.

(continued from inside front cover)

Light engineers recognize better than anyone that highly specialized systems have no place in the light soldier's pack. We need versatile, light-weight, low-bulk explosives.

We may never be able to significantly reduce the weight light engineers carry. But we can certainly increase the efficiency and utility of our load.

Our mission and lack of organic resupply mean use what we can carry or find. I hope that the new technology, like slurry or the ballistic disks, will someday find its way into our rucksacks.

1LT Thomas P. Smith is currently the executive officer of C Company 65th Combat Engineer Battalion, 25th Infantry Division (Light). He served 18 months as a platoon leader, first of a combat engineer platoon, then for a light engineer platoon. He is a graduate of USMA and has completed EOBC, Airborne School, Jungle Warfare School, and the Sapper Leader Course.

Engineer Solution

The magnetic azimuth from point A to point B is 64°.

The fact that the grids do not line up is irrelevant. On either map sheet, the magnetic azimuth is determined using the magnetic declination diagram for that map sheet.

Map A

To convert from grid azimuth to magnetic azimuth, add the GM angle:

Magnetic azimuth = grid azimuth + GM angle
Magnetic azimuth = $62^\circ + 2^\circ 5' = 64^\circ 5'$
Magnetic azimuth = $62^\circ + 2^\circ 5' \approx 64^\circ$

Map B

To convert from grid azimuth to magnetic azimuth, subtract the GM angle:

Magnetic azimuth = grid azimuth - GM angle
Magnetic azimuth = $246^\circ - 1^\circ 40' = 244^\circ 20'$
Magnetic azimuth = $246^\circ - 1^\circ 40' \approx 244^\circ$

Magnetic azimuth (A to B) = $244^\circ - 180^\circ = 64^\circ$

The grids do not line up because the maps are compiled using different universal transverse mercator (UTM) grid zones. The grid in each zone is aligned with the central meridian (line of longitude) for each zone. As the meridians converge towards the pole, the two grids must also converge.

The direction of magnetic north is independent of grid zones and will be the same—or very nearly the same—for two adjacent map sheets.

Earn your professional engineer's license

by CPT Calvin Evans

The officer with a professional engineer's license has proven competency in engineering skills and enjoys greater credibility in dealing with civilian engineers. He can also be proud of a major accomplishment—doing all it takes to acquire the license is an achievement in itself, requiring a large investment of time to apply and study for the test.

I took the exam while I was attending the Engineer Officer Advanced Course at Fort Belvoir. After finishing the test, I thought I had passed, but I wasn't sure. So I wrote myself a few notes on things to do in case I had to take the test again.

I based this article on my notes, hoping that lessons I learned in preparing for the exam will help other officers to succeed in getting their PE licenses.

General Advice:

Don't attempt the exam unless you can put the time into preparing for it.

Acquire and read "Professional Engineer—A Guide to Registration." This pamphlet, published by the Engineer School, is a good explanation of the registration process and the exam's organization. It includes a fine bibliography of commercially available guides that can help you study.

Applying to take the exam is extremely time consuming and expensive. For example, it costs $245 to take the test and get a license in the state of New York. Most states require you to apply again and pay another fee if you fail the test the first time.

When to Take the Exam

During or shortly after advanced civil schooling—If you plan to attend advanced civil schooling, this is the ideal time to take the PE exam. You can usually arrange an academic program that satisfies degree requirements while preparing you for the PE exam by including classes in your weak areas. This will also accustom you to studying for tests and give you time to study specifically for the PE exam.

During EOAC—This is a good time to take the PE exam for several reasons. First, some of the topics covered in EOAC are directly applicable to the PE exam (for example: concrete, drainage, horizontal and vertical curve calculations, soil phase relationships). Second, although homework has increased, study time is available, and you will be accustomed to studying for tests. Third, many officers take the exam every year at Fort Belvoir, and your classmates can be valuable study aids. Any other point in your career where regular study hours can be set aside for preparation is also a good time to take the test.

Applying to Take the Exam

Shop around—Unless you want a license from a particular state, it may be advantageous to request application materials from several different states. The requirements are similar for most, but the experience requirements and fees vary enough to make it worth your time to shop around. Some states may not accept your military experience as meeting the requirements. Virginia accepts most military experience.

Start early—Apply well in advance of the exam to ensure that the registration board receives all your materials before the deadline. Starting application paperwork 6 months before the test is not too early. To allow for problems, 9 months to a year is not unreasonable. Each state requires that its own forms be used for references and verification. You have to allow enough time, for example, to send a particular reference form to a registered professional engineer now stationed in Europe, wait for him to fill it in and mail it back to you, and get it to the board.

Have your endorsements sent to you rather than straight to the board—I recommend having your references return their materials to you, then send the references to the board with your application. This way, you know your application is complete when you mail it. You won't need to call the registration board to ask if your references have arrived.

Ask for more references than are required—For one reason or another, one of the people you ask to write a reference may not get it to you on time. It is extremely frustrating and embarrassing to have to ask this person (usually a senior officer) if he has completed your reference or to try to hurry him up to meet your suspense date. It is better to ask for four or five references, then send the first three you receive with your application. This should enable you to avoid wasting time following up on references.

Ask for references before you leave your unit—If you plan ahead, you can get your references before you leave your unit and avoid mailing materials back and forth to Europe. This can save you a lot of time and expense.

Studying for the Exam

Get a study guide—This will tell you the areas covered and the kinds of problems you can expect. Professional Publications, Inc. publishes excellent review manuals for the PE exam in the four major areas (chemical, civil, electrical and mechanical engineering).

Take a review course—Taking a course designed to prepare you for the PE exam can be very helpful, but is not necessary. The advantages are that this will force you to spend time studying and may help to expose areas on which you need to concentrate. Do not expect the prep course to teach you everything you need to know. These courses usually hit only major concepts and work a few sample problems in each area. Most of what you learn must come from self-study.

Start studying early—Don't wait for the day before the exam to try to learn a complete subject area.

Organize your study materials—While reviewing, it will be very helpful to tab or index your notes or books for quick reference during the exam. Good sample problems are particularly useful. The less time you spend searching through your references, the more time you will have to work the problems.

Get a good civil engineering handbook—A good handbook, such as Merritt's ***Standard Handbook for Civil Engineers***, is a helpful guide to the areas you have never studied before or for which you don't have a good reference. These are expensive, so you may want to try to borrow rather than buy one.

Study the basics in every major subject—Even if you have never studied, say, sanitary engineering, the basic concepts are fairly easy to understand. Sometimes the problems in less popular areas are significantly easier than those in the more popular areas.

Taking the Exam

Read all the problems before you start to work—The problems that you feel you can solve easily should be highlighted. Then quickly rate the problems from easiest to most difficult. The time you take to do this will be well spent.

Work the easiest problems first—You will feel more confident and relaxed after you have solved the first problem. All problems are equally weighted, so don't solve a large or difficult problem when an easier one is available.

Don't waste time copying the problem or redrawing figures—Only do this if a figure will help to show how you reached certain values.

Budget your time—If you are solving the easiest problems first, don't spend more than an hour on each one. It is better to get partial credit on all the problems rather than a "perfect" solution to only one or two.

Go for partial credit—If you are running out of time, write down the equations that show how you would solve the problem. This will be worth more points than number crunching. More weight is given to solution methods than to mathematical computations.

Conclusion

This advice may seem obvious, but it works. I hope the lessons I learned in obtaining my PE license can help those who are planning on taking the exam in the future. Good luck—and study hard!

CPT Calvin Evans is a registered professional engineer in Virginia. He served as a platoon leader, company executive officer, battalion S-4 and company commander in the 4th Engineer Battalion. A graduate of USMA, CPT Evans is doing post-graduate work in civil engineering at Stanford University.

Hotline Q & A

Q. What new 5-100 series field manuals are currently available?

A. New field manuals 5-104, *General Engineering,* and 5-105, *Topographic Operations,* should be fielded by January 1987.

Field manuals currently available are—

- 5-100, *Engineer Combat Operations.*
- 5-101, *Mobility.*
- 5-102, *Countermobility.*
- 5-103, *Survivability.*
- 5-106, *Employment of Atomic Demolition Munitions.*

These manuals can be ordered from the US Army Adjutant General Publications Center, 2800 Eastern Boulevard, Baltimore, MD 21220-2896.

Q. Are there refresher courses for field grade officers in engineer doctrine and equipment?

A. Refresher courses for field grade officers include—

- Mapping and Charting Geodesy for Topographic Assignments - 2 weeks.
- DEH Executive Management Course - 1 week.
- Combat Engineering Course, Phases II and III - 3 weeks.

A separate, 1-week refresher course to update field grade engineers being assigned as reserve component advisors or as engineer staff officers is scheduled for FY 88.

Q. How close can an M-16 rifle be to a magnetically fused mine before detonating it? How close can soldiers carrying helmets and weapons be to a mine before detonating it?

A. Magnetically fused mines are intended to respond to the metallic mass of a tank. It is unlikely that a soldier's steel pot or M-16 would detonate one of these mines. However, a good rule of thumb is to keep weapons and other metal objects at least 12 inches away.

Q. Can sand grids be used in place of sandbags for bunker construction in humid climates where sandbags deteriorate rapidly? How can I order sand grids?

A. No. Sandbags are meant to stabilize loose material without adding hazardous material to the potential area of explosion. They are easily replaced when damaged and the entire system cannot be destroyed by one impact. Sand grids provide the stability required, but are not easily replaced. Lining sandbags with sealed plastic bags prevents deterioration in humid climates.

Sand grids may be ordered through the standard AFCS channels under the NSN: 5680-01-198-7955.

Commissioned Officers Branch

Captains Promotion Board:

If you are a Reserve commissioned officer—and want to remain on active duty after your obligation date—you must apply for conditional voluntary indefinite status between the 24th and 27th month of active federal commissioned service (AFCS).

The captains promotion board and conditional voluntary indefinite (CVI) board are held at the same time.

This year, 25 engineer officers failed to file their applications until June. As a result, their applications did not arrive at MILPERCEN in time to be reviewed by the board.

To avoid delays in career decisions and uncertain career status, you should submit your application at least 60 days before the board meets. The next CPT/CVI board is from 27 January 1987 to 10 February 1987.

Promotion Packet Photos:

Officers must have official photographs in their promotion packets. Officers should have a photograph taken as soon as possible after they are promoted to 1LT.

When the last board met, 30 percent of the officers did not have a photograph in their promotion packet. Engineer Branch sent letters to all officers with no photograph in their packets, but 15 percent still did not provide a photograph.

The photograph is essential to the promotion file. (See AR 640-30, *Photographs For Military Personnel Files).*

Preference Statement:

You must have a current preference statement in your file. This provides information on assignment preferences, duty and home addresses, and telephone numbers needed to contact you. Use the comments portion of DA Form 483 to explain your choices.

Engineer Officer Bulletin:

The *Engineer Officer Bulletin* gives up-to-date information on assignments and professional development issues. The bulletin is published twice each year by MILPERCEN, Engineer Branch. The latest bulletin, Number 3, June 1986, was distributed to troop units, Engineer Districts, ROTC units and schools. The next issue will be published this winter.

Officer Selection Board:

Selection boards for FY 87 involving Engineer officers—are listed below. Officers in the zone of consideration must submit current photographs, medical examinations and corrected Officer Record Briefs through their servicing MILPO in time to reach MILPERCEN for these boards.

Board	Dates
LTC Product Manager	20 Jan - 30 Jan
CPT Army CVI	27 Jan - 10 Feb
LTC Army	18 Feb - 27 Mar
MAJ Army	3 Mar - 18 Apr
RA Army	27 Apr - 1 May
Brigadier General	9 Jun - 2 Jul
Senior Services College	21 Jul - 21 Aug
CPT Army CVI	9 Sep - 25 Sep

Engineer Branch Visits:

The following Engineer Branch visits are scheduled for FY 87. Contact Engineer Branch if your unit wants to schedule a visit. Engineer Branch visits are funded by the visiting unit.

BC, USAREUR Engineer Conference	1-5 Mar 87
BC, Engineer Proponent meeting, Fort Leonard Wood, MO	20-23 May 87

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Past in Review

Aviation Engineers in the Southwest Pacific, WWII

by Dr. James Dunn
Office of History, OCE

The Army recognized the importance of aviation engineers shortly before the United States entered World War II. The first unit — the 21st Engineer Regiment (Aviation) was activated June 1940 at Fort Benning, GA.

Following the Japanese attack on Pearl Harbor, 7 December 1941, the engineer aviation battalions contributed greatly to America's success in the Pacific. Charged with the mission of building air bases in remote, undeveloped islands and tropical jungles, these battalions played prominent roles in the Pacific theater of operations.

The 804th from Hawaii and the 805th from Panama participated in ADM Chester Nimitz's Central Pacific offensive and built air bases for the B-29 heavy bomber units.

The 803d was captured in the Philippines when Bataan fell—but not before the battalion built 12 air bases on Luzon, moved and emplaced heavy guns for the defense of Bataan, built rice mills, and repaired roads and bridges. In the final days, the battalion fought as infantry in the front line.

The 802d remained in Alaska for the Aleutian campaign.

The 808th Engineer Aviation Battalion—activated in September 1941, March Field, CA—had little time to prepare for war. The commander, MAJ Elvin R. Heiberg, held the first formation on Saturday morning, 6 December 1941. Not knowing the Japanese would attack Pearl Harbor the next day, he told his men how fortunate they were to have such fine barracks and living conditions.

Alerted for tropical foreign service, the battalion sailed from San Francisco and arrived in Melbourne, Australia on 2 February 1942.

The battalion moved to the Northern Territory to build air bases around Darwin. Over 2,000 miles from the closest American depot, the 808th began operations with only three dump trucks and two tractors. The first mail was a month late, and February pay was delayed. However, local bread and beef were plentiful; and any spare time could be spent panning for gold.

Engineers construct an airfield in the South Pacific.

From February to July, the battalion built seven air bases in the Darwin area and developed a unique method of clearing the sites by stretching a cable between two tractors and moving back and forth across the field uprooting trees.

In keeping with GEN Douglas MacArthur's strategy of confronting the Japanese in the forward area rather than waiting to be attacked, the 808th moved from Australia to Port Moresby, Papua, New Guinea, in July 1942.

For the first time, the battalion encountered the difficulties of operating in an unfriendly, jungle environment: hordes of malaria-carrying mosquitoes, jungle rot, leeches, flying foxes, heavy rain and Japanese air raids. Yet, the 808th built an air base in one month and—between August 1942 and March 1943—completed four sites in the vicinity of Port Moresby.

These and other bases provided air support to stop the Japanese attack along the Kokoda Trail, aided MacArthur's attack on Buna, and destroyed an entire Japanese convoy in the Battle of the Bismarck Sea.

The 808th continued to operate in the Southwest Pacific area. At Finschhafen, New Guinea—in what the battalion considered its greatest accomplishment—the 808th hacked an air base out of the middle of the jungle in six weeks.

On Leyte, in the Philippines, the 808th started construction of the Dulag air base one day after the area was cleared of Japanese. The field was ready two days later for emergency use by Navy planes during the Battle of Leyte Gulf.

Forty-four months after leaving San Francisco, the 808th sailed into Yokohama Harbor as part of the American occupational forces in Japan.

The battalion—that had so little time to prepare for war—contributed greatly to America's success. Among the first US Army troops to reach Australia in early 1942, the 808th Aviation Engineer Battalion helped build the long Pacific trail that eventually led to victory.

Suggestions for further reading:

George E. White, Jr., "From Pearl Harbor to Tokyo," *The Military Engineer* 38 (January 1946): 1-8.

HQ Army Forces, Pacific, Office of the Chief Engineer, *Engineers of the Southwest Pacific 1941-1945*, Volume VI: *Airfields and Base Development.*

To our readers . . .

The editor and staff of ***Engineer*** appreciate the concern of our dedicated readers about the article "*Army Kills 41 Command, School Magazines*" published November 17, 1986, in ***Army Times***. Although the program under which ***Engineer*** was previously published has been discontinued, the function still exists. While there may be changes in funding and format, the function will not change, and we are assured that we will continue to publish. However, the publication may be called a professional bulletin instead of a magazine.

While some readers may have to purchase their copies in the future, be assured that all of our Engineer units and students will continue to receive free copies. We encourage your articles for ***Engineer***, and look forward to your continued interest in our publication.

Do not despair—***Engineer*** IS NOT DEAD!

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Engineer

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THE MAGAZINE FOR ARMY ENGINEERS

Number 1, 1987

THE SOVIET ENGINEER ON THE BATTLEFIELD

A Personal Viewpoint

The Counter Obstacle Team

by CPT Frank J. Smith

Momentum is the key to success in the AirLand Battle. The combat engineer mission is to breach obstacle systems, continuously clearing the way for a rapid maneuver force initiative. This task becomes increasingly difficult as troops move through first echelon Threat forces into prepared, deliberate defenses. It's tough work, but a well-equipped, trained, and organized force can do it.

Unfortunately, we aren't ready to do that job today. Limited and outdated equipment and inadequate training programs—even at NTC—hamper engineer capability to accomplish this vital mission. And though Threat obstacle emplacement capabilities are perceived as powerful, few professionals fully appreciate Threat ability to create complex obstacle systems on the AirLand Battlefield.

A clearer picture of Threat doctrine and U.S. limitations can lead to only one conclusion: The Counter Obstacle Team (COT) concept must be adopted as AirLand Battle doctrine. Only then can the combined arms team be a combat effective force strong enough to break through complex obstacles and hold the offensive.

COMPLEX OBSTACLES—A SOVIET STRENGTH

Soviet doctrine dictates that a strong obstacle defense is the basis for a successful offense. A single lesson from history shows why. Using obstacles skillfully, the Soviets crippled the German offense at the Battle of Kursk, then took the offensive on the Eastern Front.

As this critical battle opened, the Germans attacked from the North and South, hoping to take the city in a pincer movement. On the first day, the northern pincer lost 200 tanks, 25,000 men, and its momentum. After a brief success, the southern pincer lost over 300 tanks. German progress halted short of Kursk, and the Soviets mounted their own offensive campaign.

How did the Russians do it? They stopped the attack with six integrated defensive belts defended by minefields and obstacles. Minefield density averaged 2,400 antitank and 2,700 antipersonnel mines per mile of front.

Current defensive doctrine

Threat philosophy has changed little since World War II. Echeloned forces, massed fires, shock, surprise, and complex obstacle systems are still typical of Threat defenses. Defenses range from hasty preparation for an imminent attack to prepared defenses along an entire front. The defense level depends upon METT-T.

Threat doctrine always aims to turn the defense around and mount a counterattack. Hasty defenses aim to repel or delay attackers. Expendable units hurl themselves at attacking forces that destroy or bypass hasty defenses. If Threat forces cannot regain the offensive, the prepared Threat posture is assumed.

Prepared defenses are echeloned in security, main defense area, and counterattack forces. Security forces present obstacles and direct fires to delay and deceive enemy forces. Main defense areas are complex belts of minefields, obstacles, and strongpoints designed to canalize and trap attacking forces in unfavorable terrain, where they can be destroyed by indirect and direct fires.

When the fires are lifted, expendable counterattack forces destroy the remaining enemy force. At the Battle of Kursk, the Soviets sacrificed an entire tank regiment in 3 hours in such a counterattack. Threat tactics are expensive—and effective.

AIRLAND BATTLE DOCTRINE

AirLand Battle doctrine dictates that only offensive battle leads to the complete destruction of enemy forces. To attain this goal, forces must concentrate on critical times and places, surprise the enemy, and maintain speed.

Typical scenarios require a mechanized engineer platoon to support a task force or maneuver battalion by continuously breaching lanes through obstacle systems. Since AirLand Battle doctrine offers few chances for deliberate operations, speed is essential. Assault breaches must be completed in minutes, so that maneuver units can move through obstacles quickly and continue the attack. Otherwise, maneuver forces lose momentum and risk being destroyed in place by enemy fires.

Stumbling blocks for U.S. mobility

Even in a best-case scenario for a full-strength engineer platoon with AVLBs and a CEV, engineers are ill-prepared to conduct assault breaches through the obstacle systems found in the Threat security zone and main defensive area.

Standard demolitions such as bangalore torpedos take too long to breach vehicle lanes through minefields. Line charges such as the M173 and M157 are not available for training. Moreover, these line charges will be available only in limited quantities during the first critical weeks of hostilities.

While AVLBs can span tank ditches, they cannot breach minefields. Current doctrine dictates that CEVs breach fortifications, wire obstacles, and rubble. With few exceptions, CEV crews are trained to do only those tasks, and are therefore unprepared to breach minefields.

The MCLIC, ROBAT, COV, rollers, and mine plows may one day

(continued on page 24)

Engineer

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NUMBER 1, 1987

UNITED STATES ARMY ENGINEER CENTER AND FORT BELVOIR, VA

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On the Cover

Russian armor preparing to cross an MTU-20 assault bridge under CBR conditions. The insignia shown is the Soviet engineer troop patch.

Art: Jim Wilson

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DEPOSITORY

APR 22 1987

UNIVERSITY OF ILLINOIS

CLEAR THE WAY

by MG Richard S. Kem, Commandant, U.S. Army Engineer School

Knowledge of Threat methods is vital to our readiness

As professional soldiers, we must be ready to go to war — today. We are not ready if we don't know how potential adversaries will fight. After the first bullet is fired, we will pay the price of every blind spot with lives.

In this issue of Engineer, we take a hard look at our counterparts in the Warsaw Pact and the Soviet Union. The Soviets set high standards for the doctrine, equipment, and organization of their forces. A study of their engineers gives us valuable information about the strengths and methods the Soviets will bring to the battlefield.

Let's consider the Warsaw Pact's strength. The Pact outnumbers NATO 2 to 1 in tanks, 2.2 to 1 in artillery and mortars, and 1.8 to 1 in APCs. These ratios do not give Pact forces the rule of thumb ratio—3 to 1—that the attacker needs to win. Soviet doctrine prefers the even heavier 8 to 1 ratio for attacking forces, anticipating the high losses inherent in offensive operations.

But even at current strength, the Warsaw Pact could mount a successful offensive. Presenting a mix of offensive thrusts and defensive operations across its front, the Pact could attain its desired force ratios in selected areas of attack. But this would require economy of force action in defensive sectors.

These defensive sectors could be the windows of opportunity we need to implement AirLand Battle doctrine — but only if we anticipate the Soviet defense and know how to breach it. We must also know the Soviets' offensive use of engineers in order to site our own obstacles for maximum effect. Knowledge of Threat methods is vital to our readiness.

Thorough knowledge of Soviet defense methods can help us to advise maneuver commanders on the best way to breach enemy obstacles. The engineer and his maneuver commander must develop battle drills for breaching in stride, or expect failure. This is why the Soviet capability to employ scatterable mines deserves our closest attention. It means that we may have to start breaching operations in our own assembly area and continue breaching through movement to contact and into the attack.

As engineers, you must understand the capabilities of Threat engineer equipment. You have to know the gap crossing and countermine capability of the motorized rifle regiment before you can evaluate the defensive potential of the sector your unit is defending. You must also know the numbers of different types of equipment and their places in the force structure. For example, you should know instantly that a position approached by two armored engineer tractors (IMRs) is a focus of attack, since each Soviet division has only two. In the heat of battle, this information must be in your head—there won't be time to look it up.

A firm grasp of Soviet doctrine can reveal enemy intentions and plans at a glance. If minefields are surface laid and contain no antipersonnel mines, and no work is being done, chances are the enemy will soon resume the attack. A sudden, unexplained halt in the attack followed by rapid digging in of vehicles by MDK-2 entrenchers, is a clear warning—expect a nuclear attack.

Some of you may think that the G-2/S-2 should be called upon for this kind of analysis. But as engineers, our valuable knowledge of engineer operations enables us to recognize enemy engineer courses of action. And if we know the enemy, our educated guesses are more accurate.

This issue acquaints you with our expected adversary—but more than that, it encourages you to know more about the Threat. Don't stop here. Go to your S-2s and examine studies and intelligence reports. Most of your units receive our Engineer School Periodic Intelligence Reports (PERINTREPS). Read, heed, and apply what you learn from them.

As Sun Tzu said in THE ART OF WAR—"Know yourself. Know your enemy. Then you will be victorious in a thousand battles."

BRIDGE THE GAP

by CSM Frank B. Gibert, U.S. Army Engineer School

What you can do—right now—to improve unit preparedness

Glance at this issue's cover—you see a lot of Soviet hardware. Examine the articles, and the army behind that hardware comes into focus. Read between the lines, and you catch a glimpse of the soldiers who are the Threat. Measure what you see against ***your*** soldiering, ***your*** army, ***your*** hardware. Are you ready to fight—and win?

First, consider the hardware. The descriptions in SFC Bunce's article "Soviet Engineer Equipment" (page 20) tell you what to look for, and what various pieces of equipment will do. Some items, like the towed mineplow (PMR), are similar to U.S. equipment in capabilities—and in limitations. Other items are specialized to work in unfamiliar ways, and you must use your imagination—not just your experience—to defeat them.

Think about your own hardware. Is your maintenance flawless? Are your operator skills top quality? Read this issue's article on AVLB/CEV readiness (page 32). Are you thoroughly familiar with every maintenance and training opportunity available to keep engineer equipment fully mission capable? Could you get the last ounce of speed and power if you needed it to stay with the momentum of a breaching operation?

Second, compare your assumptions about the Soviet Army with what you see on these pages. You won't meet a "best case" or "worst case" army on the battlefield—you'll be up against the real thing. The articles about historical development and current doctrine in the Soviet Army give you some valuable insights.

Pay close attention to the organization and methods of the specialized engineer detachments discussed here. Take note of the information about minefields and minelaying techniques described. Can your unit meet these units and overcome these obstacles? If not, what can you do—right now—to improve unit preparedness?

Third, take time to learn something about soldiering in the Warsaw Pact armies. The Soviet soldier is obedient, courageous, rigorously trained—and expendable. He routinely puts in 14-hour days, and is accustomed to intense, repetitive training.

It's easy to see where U.S. and Soviet military philosophies differ—we set a higher value on the individual lives of our soldiers and the quality of those lives. You can best show dedication to the lives of your soldiers through training. Confident, competent troops are ready to survive in battle—even against trained, dedicated opponents.

What can you change to make yourself and your leadership more effective?

The Soviets value unquestioning obedience. What about you? Maybe you ***do*** get obedience from your troops—but you can do better. Encourage them to "ask questions later." Listen to them for sound ideas.

The Soviets train unrelentingly. What about you? Set aside time to study Threat capabilities; schedule more training. Remember, squad-level training is the most important deterrence we have against superior numbers—and you can do more. Commit yourself to develop smart, safe trainers and establish realistic training environments. Make after-action reviews an effective part of your leadership style and your development of subordinates.

The Soviets are ready to spend lives for victory. What about you? In combat our lives will be on the line—Be ready! Make sure your unit is trained to go into battle with a better-than-even chance for victory—confident and competent because they know you have made them the "Best they can be."

CSM Frank B. Gibert is Command Sergeant Major of the U.S. Army Engineer School. He comes to the school from HHC of the 7th Transportation Group, Ft. Eustis. CSM Gibert has held numerous assignments as an Army Engineer Diver in the United States, Germany, and Korea. He holds a B.S. in Physical Education from Bowling Green State University. CSM Gibert's military education includes training in salvage diving, deep sea diving, marine engineering, air transportability, and systems analysis. He is also a graduate of the NCOES Faculty Development Course and the U.S. Army Sergeants Major Academy.

School News

Department of Military Logistics (DML)

Logistics Branch Moves:

The Logistics Branch, DML, was transferred to Department of Combined Arms on 1 October 1986. Under a memorandum of understanding signed by the directors of both units, the table of distribution and allowances was moved intact from the 809th to the 554th Battalion.

The Logistics Branch is now DCA's Combat Logistics Division, with separate logistics and maintenance management branches. CPT Cynthia Guiten is the Chief of the Logistics Branch. CW4 Pedro Arroyo is the Chief of the Maintenance Management Branch.

These units are responsible for providing logistics and maintenance management training for officers attending EOAC and EOBC, and to noncommissioned officers attending ANCOC.

52F Branch Trains on AGPU:

Resident training in aviation ground power units (AGPU) for BNCOC 52F20 students began 20 February 1987. In the past, the 52F Branch sent personnel to aviation units in the field to receive this training. AIT Training in AGPU for 52F10 students will began in October 1987. This training meets the need created by the possible future addition of 52F personnel to aviation units.

Defense Mapping School (DMS)

Reach Out and Teach Someone:

Mobile Training Teams (MTTs) provide Defense Mapping School instruction around the world. Recent MTTs have included analytical photogrammetric positioning system (APPS) training aboard Navy aircraft carriers and terrain analysis training in Active Army and Reserve units.

During 1987, DMS's scheduled MTTs to PACOM (in the spring) and EUCOM (in the fall) will export the 5-day Mapping, Charting, and Geodesy Staff Officer Course (MCGSOC) and the 4-day Introduction to Digital MC&G Data Course. The primary target audience is nontopographic staff/action officers (topographic customers), but others are welcome. These MTTs can be tailored to specific needs in each theater by adding MICROFIX-T, APPS, or other subjects. Make your need known early; contact your local topographic officer or the DMS registrar, AV 354-2383, commercial (703) 664-2383.

Department of Combined Arms (DCA)

Commandant's Writing Awards Presented:

The first Commandant's Award for Excellence in Writing was presented to CPT John McElree, EOAC class 7/86, on 12 October 1986. The second award was given to CPT Kenneth Bunning, USMC, on 5 December 1986. CPT Edward Ching, EOAC class 9/86, received the third award on 30 January 1987. Sponsored by the Association of the United States Army, the award is a plaque given to the advanced course student who produces the best research paper on the topic of his choice.

New Training-New Manuals:

Engineer lieutenants will face the myriad challenges posed by the Brigade Engineer better prepared, thanks to recent doctrinal changes in training and doctrinal writing efforts made by the Tactics, Training, and Doctrine Division of DCA. On the training side, 39 hours of instruction on engineer and manuever tactics have been added to the EOBC and grouped with existing lessons to form a 118-hour module known as "Task Force Engineer." This, coupled with new efforts in doctrinal literature, will give the Engineer lieutenant many of the tools necessary to be both a platoon leader and battalion staff officer.

Additionally, DCA is developing two new manuals to address needs from the field. FC 5-102-1, *Transition to Defense*, covers the critical period of transition in which the engineer is faced with multiple requirements and little time to complete them. FC 90-13-1, *Obstacle Breaching Procedures*, bridges the gap between FC 90-13, *Counterobstacle and River Crossing Operations,* and engineer drills.

Thoughts from a Distinguished Engineer:

The booklet *Reflections: General Bruce C. Clarke's Thoughts on Creating Outstanding Units*, an anthology assembled from the many works of General Bruce C. Clarke, former Commander in Chief, USAREUR, is now available from DCA. To order a copy, contact: Director, Department of Combined Arms, USAES, ATTN: ATZA-TC-C, Fort Belvoir, VA 22060-5341. For more information on the availability of this book, contact Department of Combined Arms, AV 354-4991, commercial (703) 664-4991.

Department of Military Engineering (DME)

Dynamite and TNT Stores to be Depleted:

The Army is no longer procuring military dynamite and TNT. Procurement of C-4 will be continued to meet all engineer needs.

Directorate of Training and Doctrine (DOTD)

Manuals Being Developed:

Field circulars for FM 5-71-100, *Engineer Operations in Support of Close Combat Heavy Forces*, and FM 5-71-101, *Engineer Operations in Support of Close Combat Light Forces*, are scheduled to be published in FY 88. FM 5-100-16, *Engineer Operations, Echelons Above Corps*, currently being developed by DME, will be out in field circular format during 4th quarter FY 87, with the FM to be fielded in FY 88.

Directorate of Combat Developments (DCD)

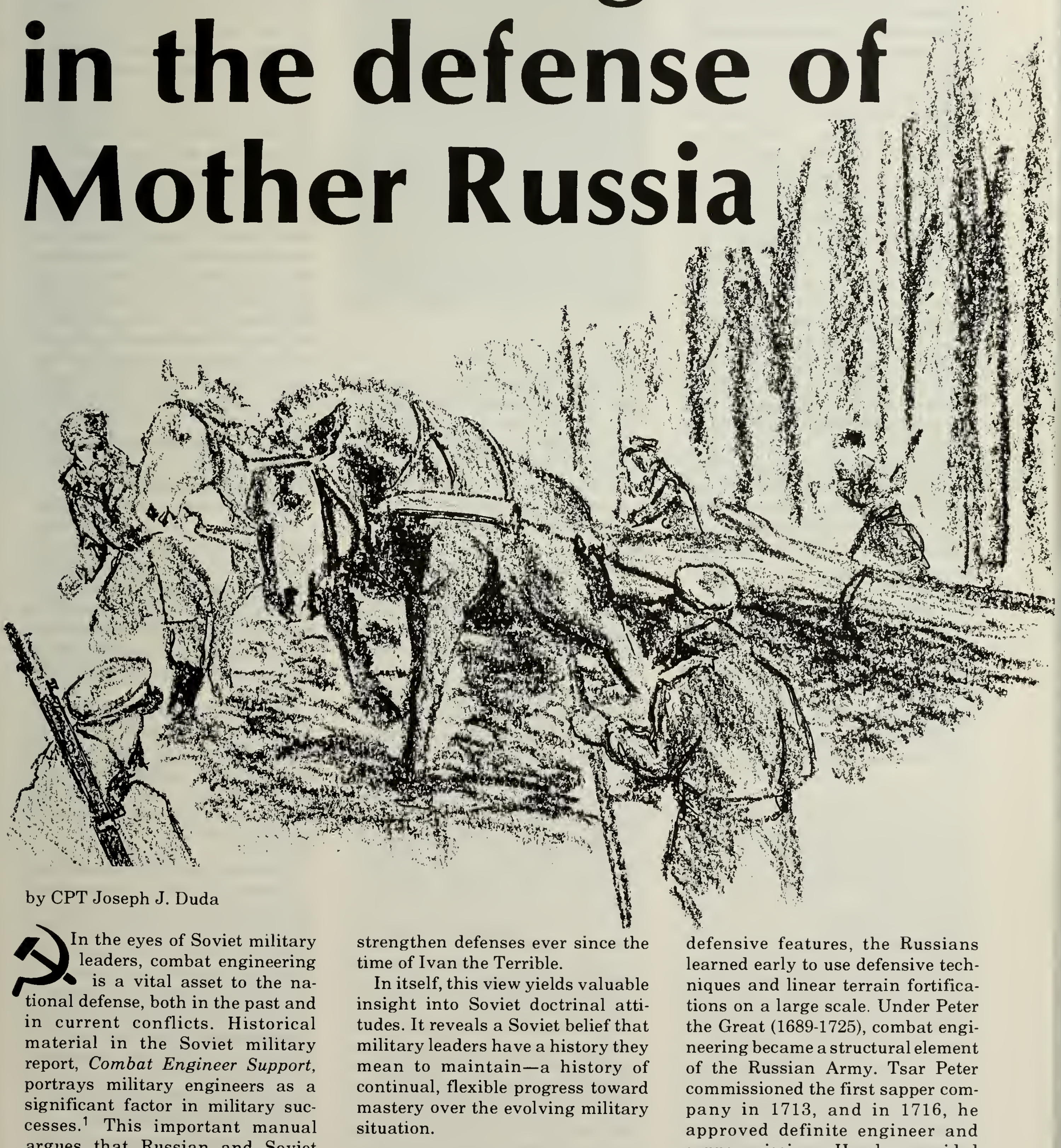
Engineer Functional Area Assessment Update:

After fine-tuning at the 8 January Proponent/ARSTAF briefing, the 1987 Engineer Functional Area Assessment was presented to the Army Vice Chief of Staff on 29 January 1987. In addition to representatives of the USAES, the briefing was attended by representatives from HQDA, TRADOC, AMC, National Guard Bureau, Chief of Army Reserves, and other MACOMs.

As a result of this FAA, 52 issues involving equipment shortages, MOS structure imbalances, and unit conversions will be worked on by the Engineer School and the various MACOMS, and progress on resolving these issues will be tracked at quarterly in-progress reviews. The Engineer School was also directed to conduct a systems program review (SPR).

A complete list of the issues, and actions to resolve them, is available. To receive this list and any other information on this FAA, contact LTC Robert McDonald, Department of Combined Arms, ATZA-CDO, Fort Belvoir, VA 22060, AV 354-3182, commercial (703) 664-31824.

Combat engineers in the defense of Mother Russia



by CPT Joseph J. Duda

In the eyes of Soviet military leaders, combat engineering is a vital asset to the national defense, both in the past and in current conflicts. Historical material in the Soviet military report, *Combat Engineer Support*, portrays military engineers as a significant factor in military successes.[1] This important manual argues that Russian and Soviet engineers have adapted and modernized to ensure victories and strengthen defenses ever since the time of Ivan the Terrible.

In itself, this view yields valuable insight into Soviet doctrinal attitudes. It reveals a Soviet belief that military leaders have a history they mean to maintain—a history of continual, flexible progress toward mastery over the evolving military situation.

PRE-SOVIET PERIOD

Since their borders lack natural defensive features, the Russians learned early to use defensive techniques and linear terrain fortifications on a large scale. Under Peter the Great (1689-1725), combat engineering became a structural element of the Russian Army. Tsar Peter commissioned the first sapper company in 1713, and in 1716, he approved definite engineer and sapper missions. He also provided for military engineer training of officers in the field forces.

During the war against Sweden (1700-1721), Russian military engineers proved their worth, building an impregnable camp at Grodno and impressive fortifications at Kronstadt. At Poltava, their technical innovations in defensive fortifications ensured a Russian victory.

Military engineering did its part in ripening the French for attrition on Russian soil during the War of 1812, as Russian fortifications exhausted and bled Napoleon's forces at Borodino. Later, Baron Henri Jomini ruefully commented: "Russia is a country which it is easy to get into, but very difficult to get out of." [2]

In the Crimean war, Colonel Franz Todleben's military engineers surrounded Sevastopol with rifle trenches and used electrically detonated mines to harass the enemy. Although the Russians were unable to break the siege, these fortifications held the British and French at bay for 11 months.[3]

Despite radical changes after 1917, the Soviets continued to put the powerful lessons of defensive military engineering to good use in securing their borders against 20th century invaders.

THE SOVIET PERIOD

In *Combat Engineer Support*, General-Colonel Kolibernov divides the development of the theory and practice of modern engineer support into three periods, each of which saw refinement of engineer support to combined arms warfare. These are—

- The Consolidation of Bolshevik Control (1920 to June 1941).
- The Great Patriotic War (June 22, 1941 to May 9, 1945).
- The Postwar Period.

Consolidation of Bolshevik Control

The lessons of World War I and the Civil War with the White forces influenced Soviet military engineering during the Consolidation of Bolshevik Control. In 1920, the future Marshal of the Soviet Union, M. N. Tukhachevskiy, emphasized the importance of engineer achievements to the Workers' and Peasants' Red Army, saying in *Engineer Support of Operations*, "The senior commander, in order to maintain full freedom of maneuver, must turn his main attention and apply his best forces and means to the conduct of military engineer affairs." [4]

By 1941, the Soviets had excellent theories on the engineer support of battle. However, they were deficient in equipment and training.

Later, Germany and the Soviets cooperated on military matters under the 1922 Treaty of Rapallo. Many Soviet officers attended German staff courses before Hitler's ascent to power in 1933. Although Stalin later executed many of these officers, the interchange of tactical ideas retained an influence. As a result, Soviet combat engineers developed techniques for employing antitank obstacles—small, flat explosive charges that could break the treads of armored vehicles.

The Red Army modernized its combat equipment as the nation industrialized in the 1930s. Its field regulation of 1936 defined engineer mobility, countermobility, and survivability tasks and areas of responsibility for different level commanders. Equipment produced to support these missions included several types of antitank mines, demolition charges, excavators, and trenching machines.

In the Spanish Civil War (1936-1939) and the Soviet-Finnish War (1939-1940), the Soviets experimented with military engineer support, developing prototypes of protective structures and several camouflage methods. As World War II approached, many of these innovations were still under development.

The Great Patriotic War

By 1941, the Soviets had excellent theories on the engineer support of battle. However, they were deficient in equipment and training. When the Germans attacked, pushing the Soviets back to the outskirts of Moscow and Leningrad, engineer support was carried out "partially and with inadequate skill." Still, engineer obstacles and support played a significant role in turning the tide of the Nazi onslaught.

On November 28, 1941, the Supreme High Command issued an order criticizing inadequate organization in engineer support of combat operations, complaining that "a significant number of regiments and divisions do not know the elementary laws and methods of individual fortifications and engineer preparation of positions." The primary engineer support missions in the defense were defined as follows:

- Prepare field defensive areas and positions.
- Emplace obstacles.
- Prepare troop maneuver routes.

The Soviets employed their restructured battalion defensive area at Kursk. There, when "forces employed deep echelon defense, the systems of trenches...permitted the successful repulse of the most powerful enemy groups, and thereafter, the changeover to an all-out counteroffensive." [5]

Colonel H. R. Dingler of the German General Staff called the Soviets "masters at digging in and erecting field foritifications. They are infallible at discovering positions which are essential for future operations." [6]

On July 2, 1943, the Supreme High Command issued the order *On the Employment and Neutralization of Mine Obstacles*. It stated: "Unfortunately, despite two years of war experience, combined arms commanders still have not learned to correctly employ mines, and our engineer troops have not learned to secretly and quickly lay and breach minefields."[7] These deficiencies resulted in several innovations in Soviet combat engineering.

To combat enemy tanks, the Soviets established mobile antitank reserves, including combat engineer units supplied with antitank mines. They also created mobile obstacle detachments (POZ) at the regiment and division level. In regiments, fully manned POZs included a platoon of combat engineers, a wheeled vehicle, and 100 antitank mines. In divisions, they included a company of combat engineers, 2 vehicles, and 300 antitank mines.

These detachments increased the combat effectiveness of obstacles and antitank artillery weapons. The Soviets also produced mine-clearing devices for tanks and a bangalore torpedo, the UZ-1, which cleared a path up to 6 meters wide. Small sapper elements that accomplished many mobility missions are also especially interesting. Kolibernov notes that these combat support elements were predecessors of the current Mobility Support Detachment (OOD).

The major engineer support missions in the offensive were—

- Prepare assembly areas.
- Clear and control passages in friendly and enemy obstacles.
- Provide close support of tanks in the attack.
- Establish and maintain crossing sites at water obstacles.
- Prepare routes for moving artillery and second echelon forces.
- Prepare obstacles for repulsing counterattacks.
- Fortify lines of advance.

THE POSTWAR PERIOD

Soviet combat engineer texts divide the postwar period into two phases. The first extends from V-E day to 1953. The second extends from 1953 to the present.

The goal is to perfect engineer support of battle in modern combined arms operations.

In the first postwar phase, the Soviets reorganized engineer support and troop training based on the experiences of the Great Patriotic War. Offensives were to start from close contact with the enemy. The goal was to perfect engineer support of battle in modern combined arms operations. Engineer support missions were—

- Fortify defensive areas, positions, and assembly areas for offensive operations.
- Breach obstacles at the forward edge and to the depth of enemy positions.
- Create and maintain crossing sites at water obstacles.

The second postwar phase, called the "second revolution in military affairs," saw the Soviets adapt combat engineer support to the nuclear battlefield.[8] It was assumed that offensives would rarely begin with close enemy contact, and rear forces would come forward to begin the offensive. Engineer troops were to clear the way, allowing a rapid advance and preventing delays that could make forces vulnerable to weapons of mass destruction.

The Soviets sought both new engineer equipment and task organizations to accomplish engineer missions on the nuclear battlefield. The primary missions became—

- Create fortifications to protect forces from the effects of nuclear weapons.
- Eliminate aftereffects of nuclear explosions.
- Prepare routes of advance through areas of mass destruction and radioactive contamination.

These complex tasks require coordination of engineer troops with civil defense troops.[9]

Soviet engineer troops are reportedly ready to perform these tasks. The Ministry of Defense paper, *Red Star,* often carries articles about the heroic exploits of combat engineers in Afghanistan. This strong focus on engineer troops at work in current battle situations shows a sober awareness that success demands further adaptation of engineer techniques and superb engineer support to combined arms operations.

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Notes

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[1] E. S. Kolibernov, V. I. Kornev, and A. A. Soskov, *Combat Engineer Support,* Military Pub. Hs., Moscow, p. 4. Unless otherwise noted, all direct quotations are from this source.

[2] Crane Brinton, Gordon A. Craig, and Felix Gilbert, *Makers of Modern Strategy,* edited by Edward M. Earle, Princeton University Press, NJ, pp. 77-92.

[3] Kolibernov et al., *Combat Engineer Support,* and Ian Hogg, *The History of Fortification,* St. Martin's Press, NY, NY, pp. 148-62.

[4] Harriet Fast Scott and William F. Scott, *The Armed Forces of the USSR,* 3d ed., Westview Press, Boulder, CO, p. 11.

[5] Scott and Scott, p. 11.

[6] F. W. von Mellenthin, *Panzer Battles,* Ballantine, NY, NY, p. 195.

[7] *Red Army Field Regulations of 1943,* trans. by Foreign Broadcast Information Service, JPRS-UMA-85-006, January 17, 1985.

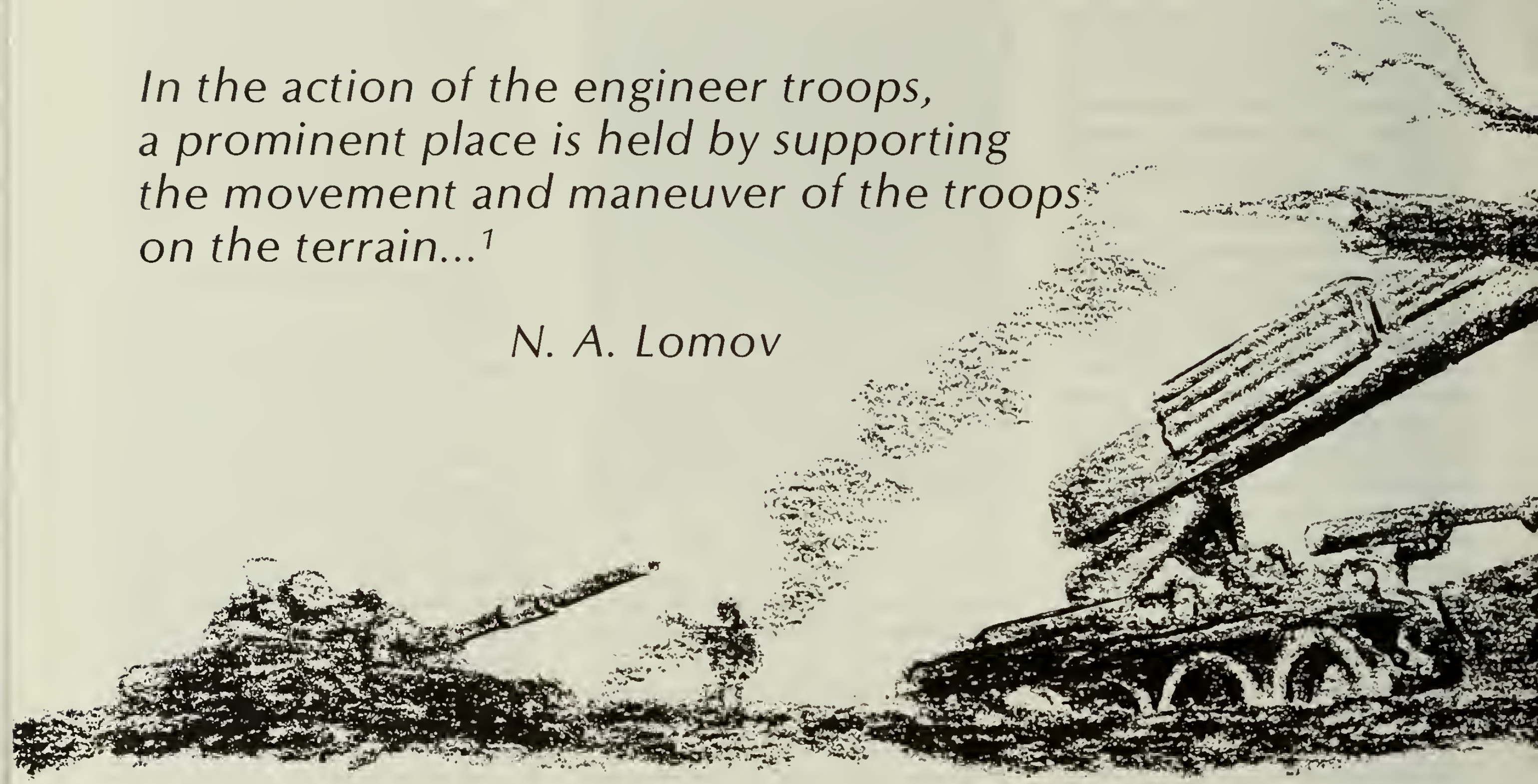
[8] William E. Odom, "Soviet Force Posture: Dilemmas and Directions," *Problems of Communism,* July-August 1985, pp. 1-14. LTG Odom describes the three revolutions in military thought which stimulated changes throughout the Soviet system. Although not directed to specifics of Soviet combat engineering, the article shows how the Soviets respond to new developments in technology and other factors affecting military power.

[9] Scott and Scott, pp. 265-66, 367, discuss current organization and missions of Soviet engineer troops.

The Soviet enginee

In the action of the engineer troops,
a prominent place is held by supporting
the movement and maneuver of the troops
on the terrain...[1]

N. A. Lomov



by SFC Peter L. Bunce

The Soviet view of the modern battlefield is no different from our own: like us, they see a lethal, fast-moving, dangerous environment. Speed, mass, breadth, surprise, and depth in the attack remain primary tenets of Soviet battle doctrine. Even though scenarios admit the possibility of conventional warfare, the brevity of nuclear battlefield time frames still rules. The Soviets expect to conduct war principally at the operational level, and to make high speed offensives the *tour de force* of their operational art.

High-speed offensives rely on simple, easily executed tactics. On the modern battlefield, such tactics depend upon ample engineer support. This article explores the use of engineer elements in the Soviet Army's ground forces.

ORGANIZATION

Engineers in the Red Army

Engineer troops in the Soviet military structure are independent of the service branches, reporting directly to the Minister of Defense. Engineers maintain their own military schools system for officers. The Higher Military and Military Command schools are equivalent to a combined West Point and officer basic course. The Military Academy is roughly equivalent to a combined officer advanced course and CAS3. Still another technical engineering school offers a five-year curriculum.

The engineers provide support "for combat operations of all services and service branches" and "are subdivided into general (combat engineer) and special categories (pontoon and bridge, assault crossing, highway, works service, camouflage, construction, and others)." Engineer units may be components of ground force units or assigned "to an army, front, supreme command reserve, navy, air, or one of the other services of the armed forces."[2]

In the ground forces, one engineer company supports each division's four maneuver regiments, and one engineer battalion supports the division. Bridging and assault crossing units excepted, Soviet engineer units are equipment- and personnel-holding units whose subordinate elements are task-organized into specialized engineer detachments.

The divisional engineer battalion

The divisional engineer battalion consists of a headquarters company and four line companies: a sapper company, an engineer road company, a pontoon bridge company, and an assault crossing company. The battalion's structure and organic equipment are shown in the table.

The regimental engineer company

The regimental engineer company is a divisional engineer battalion, without bridging or assault crossing elements. It has a headquarters and services platoon, a sapper minelayer platoon, a road-bridge platoon, and two sapper platoons mounted in personnel carriers.[3]

Engineer detachments

Except for bridging and assault crossing units, both regimental engineer companies and divisional engineer battalions organize their

on the battlefield

subordinate elements in the same way. The major detachments are the Movement Support Detachment (OOD), the Engineer Reconnaissance Patrol (IRD), the Reconnaissance/Obstacle-Clearing Detachment (OR), and the Mobile Obstacle Detachment (POZ).[4]

The OOD is usually built around a road company. It moves 1 to 2 hours ahead of the main force, reconnoiters the main march route, removes mines and similar obstacles, bridges water obstacles, and marks routes along each main axis of advance.

The IRD is often attached to other reconnaissance elements to scout routes of march and estimate requirements for removing obstacles.

The OR essentially performs the mission of the OOD and the IRD, although it can operate as part of an OOD.

The POZ is formed by divisional and regimental level engineers around minelayer platoons, sometimes reinforced by sappers: the POZ often works with the Antitank Reserve, especially in the offensive.

Based on scales of equipment, it appears that the divisional engineer

Divisional Engineer Battalion

Unit	Equipment
Headquarters company	
Reconnaissance platoon	
Sapper company	
Headquarters platoon:	Mine plows, mine rollers, dozer blades
Minelayer platoon:	Three GMZ self-propelled mine plows
Sapper platoons (2):	Armored personnel carriers
Road company	
Road platoons (2):	BAT-dozers, TMM truck-mounted scissor bridges, AVLBs, IMR engineer vehicles
Bridge construction platoon:	Bridging elements, crane
Field fortification platoon:	BTM or MDK ditch diggers
Pontoon bridge company:	Half-set of PMP ribbon bridge, 118 meters of class-60 bridge, longer elements with lower classifications, or rafts of various sizes
Assault crossing company:	Twelve K-61/PTS/PTS-M tracked amphibious transporters
Platoon:	Three GSP-ferry sets (or two platoons, six GSP sets in tank divisions)

Source: Isby, David C., *Weapons and Tactics of the Soviet Army* (London: Jane's, 1981), p. 331.

battalion is more capable of deploying both an OOD and an IRD, while the regimental engineer company is more likely to use an OR.[5]

Employment of engineers in battle

As the basic tactical unit of the Soviet ground forces, the regiment has its own organic engineer support. At division level, the Soviet commander can use his engineer elements to support the main axis of his advance, thus reinforcing his main area of interest without requiring reinforcement from the Army. In turn, the Army can use its engineer units to reinforce its own major axis.

Engineers in the attack

The employment of engineer detachments is keyed to the Soviet preference for tactical and strategic surprise. The aim is to attack when opposing units are not in defensive positions, and to attack from the march. Thus neither side has the benefits of the defense, and must fight the Soviets' preferred type of combat, the meeting engagement.[6]

Engineer support is designed to maintain the momentum of the Soviet advance. The division deploys its OODs and IRDs along its major axis of advance, and the regiments put out their ORs along their major axes. Depending on enemy opposition, the OODs and ORs operate as far in advance of the major elements of the units as possible, preferably with or ahead of the marching unit's advance guards. The ORs also remove obstacles to flanking or enveloping attacks.[7]

During the advance or attack, the POZ, often teamed with the antitank reserve, is usually placed centrally in the unit's deployment—between the first and second echelons. It counters threats to the unit's flanks by quickly deploying antitank minefields covered by the antitank missiles or guns of the antitank reserve.[8]

Engineers in the defense

Engineer elements are integrated into the combined arms operation in the defense. Much OOD and OR equipment can be used to reinforce defenses, although the POZ is responsible for defensive minefields and demolitions while still being available, with the antitank reserve, to block penetrations into unit defensive positions.[9] (See "Soviet Countermobility Operations," p. 14.)

River-crossing operations

Each Soviet division has both a pontoon bridge company and an assault crossing company. Most Soviet armies also have pontoon bridge regiments and assault crossing battalions. A typical pontoon bridge regiment can put in six times the amount of bridging the divisional engineer battalion can, while the assault crossing battalion normally musters 3 dozen tracked amphibians and up to 2 dozen GSP ferries.[10]

The Soviets exercise their bridging capability often, and large river crossings are often a highlight of major exercises. In Druzhba 84, held in Poland, engineers accompanied forward detachments to the water obstacle. The commander decided to force the river obstacle under the cover of night. "In a very short time both shores of a deep water obstacle were linked by a pontoon bridge. The fording operation by mechanized and armored subunits and artillery lasted several hours."[11]

An assault river crossing from the march, the preferred method, starts as forward detachments of the marching regiments and divisions arrive at the water obstacle, where they immediately attempt to seize bridges "and other operating crossings." Advance guards then arrive. They destroy enemy units, screen approaches, and attempt to force a crossing, primarily with amphibious personnel carriers on the move to develop the attack in depth. Pontoon bridge subunits, moving with the forward detachments, start building bridges as soon as the opposite bank has been seized and small arms fire is no longer a serious danger.

The unit main body approaches the water obstacles at maximum speed, its high crossing rate hastened by amphibious transporters and ferries. Tanks usually do not snorkle the water obstacle.[12]

In a deliberate river crossing, engineers prepare roads and crossing sites, loading points for amphibious transporters, preparation sites for snorkeling tanks, and points for unloading bridging. Most personnel carriers cross the river while artillery preparation is still raining down on the far bank. At the same time, tanks prepare to snorkel the water obstacles.

As personnel carriers begin to secure the far bank, tanks follow underwater. Engineer subunits accompany the forward elements and, as they advance, begin to prepare the far bank for bridging and ferrying. As soon as the far bank is secure enough, bridge units hit the water. The operation then proceeds like the assault from the march.[13]

Extraordinarily elaborate preparations are a matter of record. Expatriate Soviet officer Viktor Suvorov's book ***The Liberators***

Notes

[1] N. A. Lomov (ed.), *Scientific and Technical Progress and the Revolution in Military Affairs*, Moscow, 1973 (translated and published by the U.S. Air Force, 1975), p. 106.

[2] Harriet Fast Scott and William F. Scott, *The Armed Forces of the USSR*, 3d ed., Westview Press, Boulder, CO, 1984, pp. 265-66.

[3] David C. Isby, *Weapons and Tactics of the Soviet Army*, Jane's, London, 1981, p. 331.

[4] Ibid, pp. 327-29.

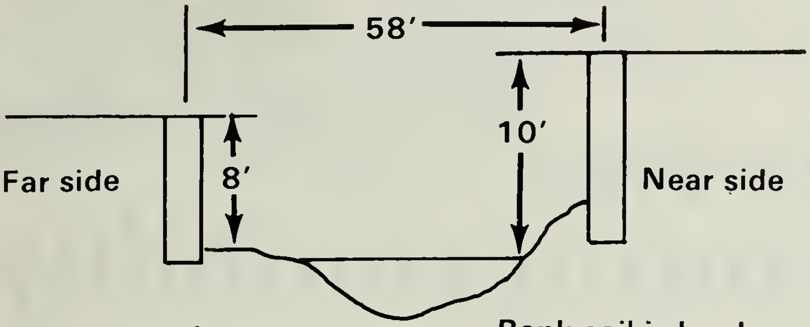
[5] Peter L. Bunce, "The Soviet Reaction to a Flank Threat," *Armor*, November-December 1985, pp. 28-29.

[6] Charles Dick, "Concepts of Operation: Organization, Plans, and Prospects," and Christopher Donnelly, "The Face of the Future Battlefield," lectures presented at the Royal United Services Institute for Defense Studies, 1 March 1984. From unofficial notes by the author.

Engineer Problem

During a bridge reconnaissance, you gather the appropriate information needed to design a Bailey bridge. The required crossing classification is 60 traffic. Determine the following:

1. **Initial bridge length.**
2. **Construction type.**
3. **Initial grillage type.**
4. **Roller clearance.**
5. **New bridge length.**
6. **New truss type.**



Bank soil is hard consolidated clay.

REFERENCE: FM 5-277, Bailey Bridge, Chapter 4

Problem/Solution submitted by CPT Steven W. Chandler, Department of Military Engineering.

reports that in a river-crossing exercise, on the Dnepr in 1967, the Soviets actually paved the river. In fact, steel mesh was placed on the river bed and concrete panels formed corridors across the river bank. The panels prevented snorkeling tanks from becoming disoriented. The steel mesh on the river bottom was used to support the large number of tanks (5,187) expected to cross the river.[14]

This feat, propaganda ploy though it may have been, was nevertheless an impressive engineer achievement. Other exercises, such as Druzhba 84, suggest that Soviet river-crossing methods are effective.

Soviet engineering troops are perhaps the world's largest and most lavishly supported engineer corps. They are a critical force multiplier in the high-speed offensive, the centerpiece of Soviet operational art. Well-supported with a variety of specialized engineer equipment and fielded in greater force than most of their Western counterparts, Soviet engineering troops are formidable opponents on the modern battlefield.

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[7] Isby, p. 331.

[8] Bunce, pp. 28-29.

[9] Isby, p. 329.

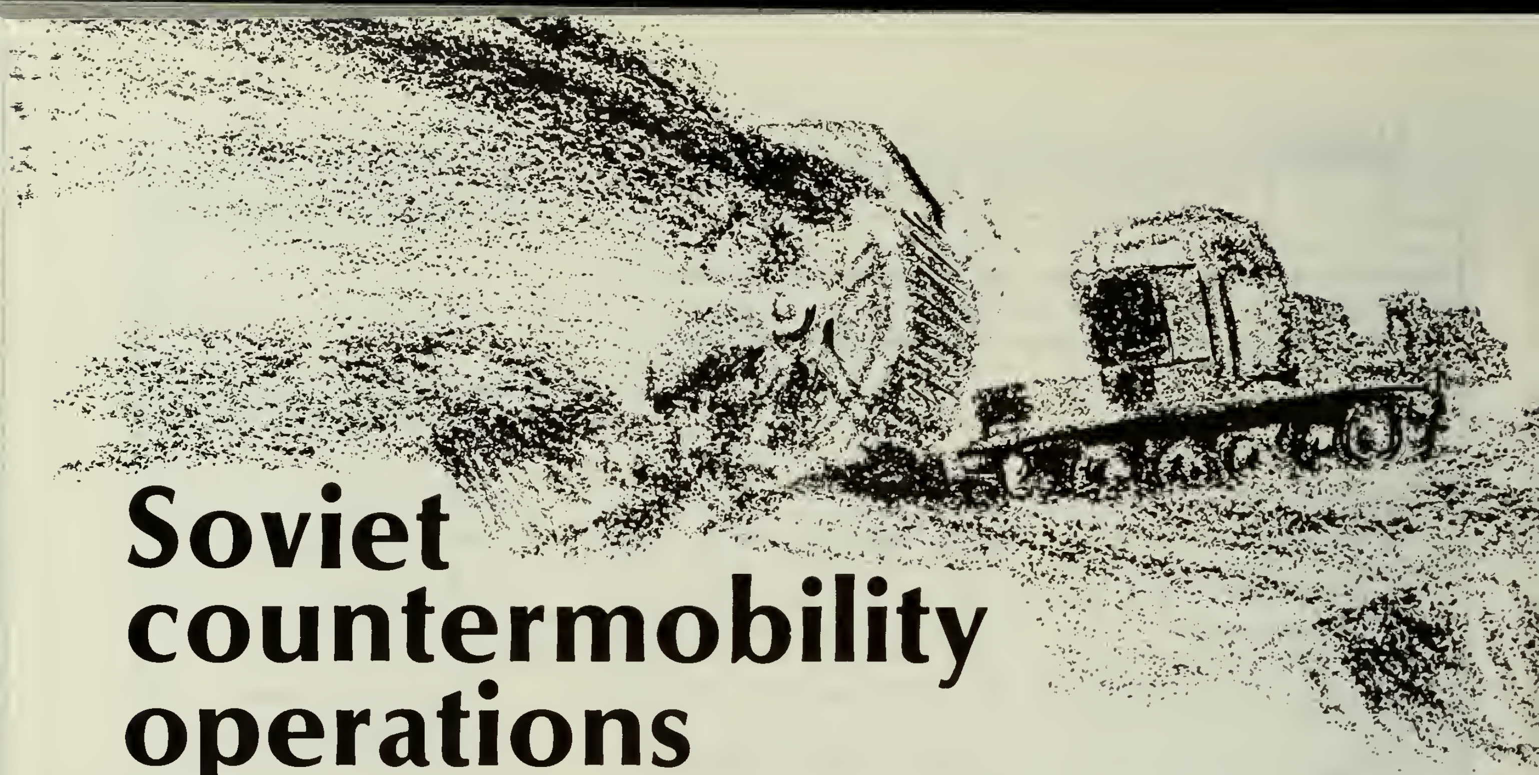
[10] Isby, p. 331.

[11] "Warsaw Pact Exercise in Poland," *Jane's Defense Weekly*, 18 August, 1984, pp. 230-31.

[12] A. A. Sidorenko, *The Offensive*, Moscow, 1970 (translated and published by the U.S. Air Force, 1976), pp. 194-95.

[13] Sidorenko, pp. 197-99.

[14] Viktor Suvorov, *The Liberators,* Hamish Hamilton, London, 1981, p. 70.



Soviet countermobility operations

by COL Frederick E. Parker, III

As a Soviet force prepares to mount an assault, units move forward to form-up areas. Each subelement commander's initial activity is to identify defensive positions for his weapon systems. Crews and engineer equipment operators begin to dig defilade positions for weapons; they keep digging until the assault begins. In the form-up area, the commander develops a fire plan and chooses locations for engineer obstacles. The unit now has fall-back defensive positions and a detailed plan to be used if the initial attack fails. As part of the fire plan, engineer obstacle sites are chosen along the avenue of advance to deny mobility to opposing forces.

This typical countermobility operation is an integral part of the planning and execution of all aspects of Soviet operations.

Soviet engineer obstacles

Engineer obstacles include any actions taken to inflict losses and to delay and impede movement in all types of battles. Their obstructive effect is directed against land forces, watercraft, and helicopters. In the attack and in meeting engagements, Threat obstacles cover forward areas and flanks, repel counterattacks, and strengthen captured positions.

In the defense, where they cover strong points and reinforce natural obstacles, engineer obstacles have added importance—here, the ability to make more extensive use of them is a major advantage.

Emplaced obstacles repel the enemy, reduce the tempo of the attack, and impede enemy operations. They are built to conform to terrain, current weather conditions, and prevailing climatic conditions. Designed to remain firm against enemy fire power and breaching efforts, obstacles must allow the attack force to remain mobile and must work as an integral part of the fire plan.

Explosive obstacles are created by means of high explosives, liquid explosives, and mines. Nonexplosive obstacles, such as wire obstacles, earth works, abatis, and dragons' teeth, are constructed.

Mixed minefields, discussed at length below, are the primary obstacle used by Soviet forces in combined arms battle. They can be quickly emplaced, and they are difficult to breach. In front of protective positions and entrenchments, they automatically create effective combined obstacles.

Obstacle complexes—natural and engineer obstacles clustered in a relatively small area—deny use of critical avenues of approach. An engineer company may prepare a system of obstacle complexes on avenues of approach up to 30 kilometers long, particularly on constricted roadways. The company starts at the front and works toward the rear. At naturally constricted areas, obstacle complexes tie the natural obstacle to a series of point obstacles such as road craters, bridge demolitions, off-route mines, and small minefields that block approaches and bypasses.

Antitank (AT) ditches may be mechanically dug after all survivability positions are prepared. In some terrains, antitank ditches are created by use of explosives. This method is used in the hard ground of clay/rock desert areas, in frigid northern regions, and in coastal areas, where such ditches are less vulnerable to wave action than mines.

Mixed minefields

Since mixed minefields are the most commonly encountered Threat obstacle, they deserve close examination. Threat mixed minefields differ from their U.S. counterparts, in which antitank and antipersonnel (AP) mines are often placed in the same minefield. Instead, the Soviets lay a mixture of antitank and antipersonnel fields. Antipersonnel fields, laid in front of Soviet forces and antitank minefields, are intended to strip the infantry and engineer breaching elements from attacking enemy tank forces.

The basic characteristics of mixed

minefields are their density and their mine outlay. In Soviet minefield doctrine, the term density is used to express the amount of position frontage protected by minefield obstacles, in meters. Mine outlay expresses the number of mines per kilometer of minefield.

Soviet minefields do not form a long, thin line. They are a series of short interrelated obstacles placed across tank approaches. Some Soviet authors indicate that spacing between minefields should prevent attacking tank platoons from clearing the gap, but that friendly movement should be possible to units that know where the gaps are.

Minefield laying methods

The mixed minefield may be laid by hand, machine, or remote means, and is always covered by fire. Mixed minefields are emplaced by both engineers and combined arms elements. Engineers and remote minelaying systems are responsible for minefields in front of the forward edge of battle and on primary avenues into formations. Combat arms elements emplace obstacles to cover positions and occupied areas.

Whenever possible, minefields are emplaced at night in order to achieve surprise throughout the defense. Combat arms units hand emplace minefields in front of the forward edge of their position. In contact, antitank minefields are emplaced using a mine cord laid perpendicular to the front. When the unit is not in contact with the enemy, mine cords are laid parallel to the front. A trench is dug to establish a starting line for minelaying. Combat arms crews may also use a pace method.

A temporary combat formation known as the mobile obstacle construction detachment (POZ) is an important Soviet engineer force element. This is a platoon-sized to company-sized element with minelaying equipment and logistics vehicles that carry explosives and mines. A typical regimental POZ with three towed mineplows (PMR) carries 1,200 AT mines, 2,000 AP mines, 3 tons of high explosives, and 10 to 20 shaped charges. The POZ's load may be greater under some circumstances.

Typical antitank minefield

Front	200 - 300 meters
Depth	60 - 120 meters
Distance between rows	20 - 40 meters
Number of rows	3 - 4 meters
Distance between mines	4 - 6 for antitank mines 9 - 12 for antihull mines
Outlay "normal"	550 - 750 antitrack mines
Outlay "increased effectiveness"	1,000 + antitrack 500 + antihull
Probability of destruction "normal"	approximately 0.57 antitrack (750/km) approximately 0.85 antihull (400/km)

Typical antipersonnel minefield

Front	30 - 300 meters
Depth	10 - 50 meters
Distance between rows	5 meters or more
Distance beween mines	1 meter for high explosive, 2 times lethal radius for fragmentation
Outlay "normal"	2,000 - 3,000 for high explosive 100 - 300 for fragmentation
Outlay "increased effectiveness"	2 - 3 times normal
Probability of destruction	0.15 to 1.2 for HE (2,000/km) 0.1 to 0.15 for Frag (100/km)

The POZ creates obstacle complexes and defensive obstacles, and lays mines during battle. While it acts independently to establish obstacles in defensive preparations, the POZ usually works with the antitank reserve during a battle. Potential obstacle emplacement locations are designated for the POZ at each halt during movement. The detachment receives straightforward orders—"place an antitank minefield from that barn to that clump of trees."

Engineer-sapper units emplace mines beyond the forward edge of battle positions. Mechanical minelayers, trucks, armored vehicles, and helicopters with chutes supplement hand emplacement. Mechanical minelayers work at rates of 600 buried mines per hour to 2,500 surface-laid mines per hour. Thus a POZ equipped with three minelayers could, in 15 minutes, lay a buried minefield covering 1 kilometer or surface lay a similar minefield in 5 minutes.

The Soviet obstacle defense is characteristically deep, and extends into their rear area. On dangerous avenues of approach, obstacles are emplaced by remote means or by inserted obstacle detachments, partisans, or special operations teams. Terrain and combat situation always dictate the method for mining and the distance between rows. False minefields may conceal minefield locations and obstacle systems.

Armies that oppose Soviet or Soviet-trained forces can expect to meet obstacle systems that enhance natural obstacles and show the imaginative use of explosives and mines.

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AirLand Battle Doctrine —the Red Army responds

by CPT F. Michael Real
and Penelope Schmitt

After watching the Red Army operate under a first strike doctrine for more than three decades, western analysts saw a change. In 1979, the Frunze Academy launched a major study of defensive operations. At the same time, the Soviets suddenly fielded new combat engineer equipment, including heavy earthmoving vehicles and scatterable mine systems. Why?

The recent appearance of the Soviet Manual *Engineer Support of Combat in Special Conditions*[1] suggests an answer. It formulates the Soviet engineer response to U.S. AirLand Battle Doctrine and to NATO's Follow on Forces Attack concept. Like AirLand Battle doctrine, FOFA calls for strikes behind the enemy forward edge of the battle area. The goal—destroy or cripple opposing armies before they can fully commit their forces to an attack.[2]

The Red Army Response

The Soviet prescription for successful attack requires heavily massed forces. It defines a 3 to 1 ratio of superiority as minimal. But the Soviets now appear to want ratios of up to 8 to 1 to assure success—they expect heavy losses on the AirLand Battlefield.

Warsaw Pact materiel superiority over NATO forces actually runs at a ratio of only 2 to 1. Attacks must be concentrated if the Soviets are to achieve desired strength. Elsewhere on the front, the Soviets must economize, relying on defenses to prevent an enemy breakthrough.

To maintain the attack on the AirLand Battlefield, the Soviets see an urgent need to preserve mobility. "Under these conditions it is expedient to echelon forces and means of reconnaissance, to overcome obstacles throughout the entire depth of the troop formations, and to ensure constant readiness for employment. It is also necessary to quickly neutralize the enemy's remote mining with artillery fire and air strikes."[3]

Among Soviet countermeasures, the most important is the tactic of deploying scatterable mine systems (FASCAM) against reconnaissance, communications, command, and control systems (C^3). Since C^3 assets are critical to coordinating a combined arms attack, protecting them must now be a top priority task.[4]

The Red Army is also taking steps to enhance the survivability of attacking elements. More traffic control personnel are being fielded to guide troops and vehicles through areas infested with remotely delivered mines. More elaborate camouflage, deployments concentrated in radar dead space, and heavier terrain fortifications can also be expected.

Troops may be more dispersed, and armor is unlikely to be openly

deployed in columns in the rear areas. Tactics to protect armored vehicles and self-propelled weapons reportedly include setting small fires along advance routes, to draw heat-seeking munitions away from their intended targets.[5]

The Engineers' Role

The Soviets are building an increased engineer capability to fight the AirLand Battle. In the past, Red Army doctrine has placed engineers squarely in the front lines. In rear areas, engineer tasks centered on water supply and logistical mobility. Now Soviet concern for survivability, mobility, and countermobility in depth calls for combat engineer presence through the entire battle area. This includes—

- Greatly increased earthmoving and entrenching capabilities to enable armor and troops to dig in as a defense against deep strike munitions.
- Increased countermine assets in response to FASCAM, deployed around assembly and supply areas and lines of communication to counter FASCAM and other rear area obstacles.
- Highly mobile engineer teams available to support gap-crossing sites throughout the battle area, and stockpiles of structural assets near all likely crossing sites to respond to expected accurate, deep strikes against bridge and crossing sites.

Implications for the West

The message is this—the Soviets are on to us. They are moving to adopt strategies and weapon systems similar to our own. They are diagnosing our tactics to invent defenses that can degrade our effectiveness—and countermeasures that can cripple an attack.

On the positive side, AirLand Battle doctrine is causing the Warsaw Pact armies to invest heavily in defensive equipment, personnel, and strategy for the first time in 30 years.

But the Soviets have consistently found ways to restructure and redeploy their assets in order to counter powerful enemies. If we are to maintain the offensive strategy inherent in AirLand Battle doctrine, we can't let our tactics become stale formulas, or assume that our defenses are impregnable.

Today, we hold the initiative. Only continued inventiveness will allow us to keep it.

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Penelope Schmitt is Features Editor for ENGINEER.

Notes

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[1] *Engineer Support of Combat in Special Conditions*, 1985; translated from Russian by U.S. Army Foreign Science and Technology Center, FSTC-HT-1024-85 (August 1986).

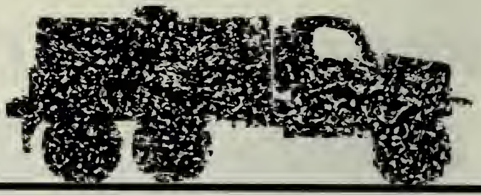
[2] Sally Stoecker, "Soviets Plan Countermeasures to FOFA," *International Defense Review*, November 1986, p. 1607.

[3] *Engineer Support of Combat in Special Conditions*, p. 175.

[4] For a recent discussion of this issue, see MG Thomas S. Swalm, USAF, "AirLand Battle Doctrine and the C^{3}CM Strategy," *AirLand Bulletin* No. 86-4, 31 December 1986, pp. 6-10.

[5] Stoecker, p. 1608.

Water supply to Soviet ground forces



by Dr. Donald E. Nease

Conflicts are won as much by knowledge of the enemy as by force of arms. Although this primary principle of military education is often invoked, we seldom give Threat combat service support activities the scrutiny they deserve. A moment's reflection makes it clear that support is vital to the success of any mission, and should draw as much attention as we give, say, the Soviet second echelon. An important and often neglected aspect of such support is water supply. Disrupting or degrading this essential supply could severely impede a Threat offensive.

USING WATER

Water is of the utmost importance to combat units. An adult's normal physiological water requirement is about 3 liters a day, but the body may demand 10 to 12 liters to do stressful work in high ambient temperatures.

The Soviets reflect these needs in precise water-use norms. For combat personnel, their norm is 10 liters per day; in high temperatures, 15 liters. A division may use up to 150,000 liters of drinking water daily. Under adverse conditions—especially in contaminated or arid areas—water is issued at the minimum rates of 2.5 liters per person (for no more than 5 days in moderate conditions) and 4 liters (for no more than 3 days in hot weather).

The Soviet consumption norm for sanitation and bathing is 45 liters per person per day. A division will use 675,000 liters per day for these processes.

Impotable water can be used to decontaminate and disinfect weapons, equipment, and supplies. The Soviets have developed detailed water norms for these tasks, ranging from .5 liters for cleaning an assault rifle with damp cloths to 600 to 1,000 liters to decontaminate a vehicle with a water jet.

Amounts needed for simple washing and vehicle supply include 75 liters to wash a wheeled vehicle and an estimated 1.5 liters a day to keep its radiator filled.

SUPPLYING WATER

Soviet water supply doctrine covers both potable and impotable water, and states that the threat of "enemy use of mass destruction weapons" (NBC weapons) creates an urgent need to hold adequate supplies in both water-abundant regions and desert and semiarid areas. This doctrine indicates preparedness for large-scale contamination of open water reservoirs and other sources.

Tasks that support water supply to troops in the field are divided among various units. Reconnaissance and acquisition of water sources and water purification are performed by the unit's organic engineer component. At regimental level, this means a company of about 60; at division level, a battalion; and at army level, a regiment.

Equipping the water supply point and distributing water are engineer functions. The chief of the Chemical Service and the Senior Regimental Surgeon maintain constant dosimetric, chemical, and sanitary control over water quality. The NBC instructor, dosimetry officer, and chief paramedical officer (Feldsher) of the battalion monitor water sources. These organizations often conduct water reconnaissance activities. The using units must protect and maintain their water distribution points and equipment.

Water supply and distribution points

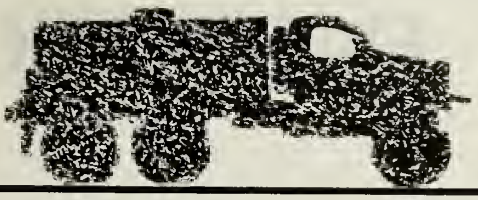
Water supply points at water sources are often set up close to the battalion. Detachments that operate separately from the main forces receive water and hot food at the same time. In the defense, it is considered expedient to put supply points in the various company or battery areas, inside or near the defensive perimeter. When arid conditions, scarcity, or contamination make it impossible for battalions to have individual water supply points, troops receive water from water distribution points. These supplies of transported water reserves are located in or near the regimental area.

Criteria for selecting a water supply point include not only the quantity and quality of the water, but also the availability of sidings, suitable roads, and protective and camouflaging terrain. Soldiers set up a sanitized protective zone with a radius of 50 to 100 meters around each point. Markers and/or signs indicate the points, distribution locations, and access routes. Control posts are set up on the approaches.

On rivers and streams, water distribution has these priorities: water supply points, bath facilities, water for animals, and vehicle washing. Bunkers and trenches protect personnel and equipment near the supply point, and all equipment is camouflaged.

Drilling for water

Soviet doctrine encourages use of



surface water and existing water networks because of the ease of supply. When these sources are unavailable, the army is fully prepared to drill for water.

Three drills available in the Soviet inventory are the MsChak-15, UDV-15, and UDV-20. All are auger-type power drills operated by two men. Each can extract water at a depth of 15 meters. These drills have a special tap for breaking rock and a built-in filter and piston pump that makes newly-drilled wells productive immediately.

The MsChak-15 can be set up in 1.5 to 2.5 hours by two soldiers, and can extract 1,300 liters per hour. The UDV-15 can be emplaced in 1 to 2 hours by two people and will produce 2,000 liters per hour. The UDV-20 can extract water at a rate of 1,800 to 2,000 liters per hour.

Pumping equipment

The Soviets use several pumps. The small tubular pump, MTK-2M, can be used for ground water up to 7 meters below the surface, pumping water 10 to 20 meters above the surface. The pump can be set up by three or four men in 3 to 4 hours; it extracts 1,300 liters per hour.

For open basins or wells with a maximum depth of 6 meters, the Soviets use the BKE-4 pump, its capacity is 2,400 to 3,600 liters per hour. Two soldiers can set up this pump in 20 minutes.

The M-600 motor pump is used to pump water from large basins. Its 12-horsepower engine pumps 3,600 liters per hour with a crew of two.

The KPN piston pump can pump 5,000 liters per hour from shafts over 150 millimeters in diameter. Its workable depth is 90 meters.

Storage equipment

For water storage, Soviet forces use flat containers of rubberized fabric with the designations RDV-5000, RDV-3000, RDV-1500, RDV-100, and RDV-12. The numbers indicate liter capacity. The 5,000- and 3,000-liter tanks are protected with attached covers, while the necks of the smaller tanks are tied for protection.

These tanks are disinfected and set up at water distribution points in enclosed sites on level areas cleared of objects that might puncture the fabric. If extended storage is planned, troops cover the soil beneath the tanks with boards, straw, and rushes.

Other water-holding devices in the Soviet inventory include the AVTS-28 tank trailer (2,800 liters), RTS-1200 tank cistern (1,200 liters) RE-6000 tank (6,000 liters), BTR-100 tank (100 liters), and RB-12.5 backpack wineskin (12.5 liters).

Purifying water

To keep water potable over an extended period, it is chlorinated up to 0.8 to 1.2 milligrams per liter. Boiled water can be stored for a day, then it must be boiled again or chlorinated. To distill water, the Soviets use the POU and POU-4, each of which can produce 300 liters per hour of fresh water. The OPS, a truck-mounted distiller, can produce 1,800 liters per hour. Each of these devices requires a set-up time of 90 to 120 minutes.

The MAFS-1 automatic filtration station is one of several items the Soviets use to purify ground and surface water. This purification system can supply up to 2,000 cubic meters per hour and requires a five-man crew and driver. Water is pumped from the source to rubberized fabric tanks where coagulation and sedimentation take place. It is then pumped to the MAFS-1 unit where it is filtered, decontaminated by activated carbon and/or ion exchange, chlorinated, dechlorinated if necessary, and then stored in other rubberized fabric tanks for distribution.

The MAFS-2 can purify water uncontaminated by radioactivity at a rate of 8,000 liters per hour and radioactive contaminated water at a rate of 4,000 liters per hour. The MAFS-3 is a truck-mounted filtration station which can purify naturally, chemically, and radioactively contaminated water. Assembled on a truck and two-axle trailer, the MAFS-3 consists of a filter, 2 dechlorinators, 3 M-600 motor pumps, RDV-5000 rubberized tanks, instruments, and filtering agents. Production rates are 7,000 to 8,000 liters per hour.

Clearly Soviet water supply doctrine plans meticulously for the tactical problems related to water supply just as they have for other combat service support functions. In the Soviet Army nothing is left to chance. However, war is often ruled by the unanticipated. It seems likely that the realities of battle could upset these rigid norms and jeopardize Threat operations. This is NATO's challenge.

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SOVIET ENGINEER EQUIPMENT

by SFC Peter L. Bunce

Soviet engineer units are lightly manned compared to U.S. units. Regimental engineer companies have 60 to 70 officers and men; divisional engineer battalions in tank divisions have about 30 officers and 400 men.[1] This compares to about 150 in a U.S. Army engineer company and about 900 in a divisional combat engineer battalion.

Equipment makes up the difference—Soviet engineer units have more machines, and they are highly specialized (see the table).[2] This article reviews the characteristics of newer and important systems in the Soviet engineer components.

TMM—heavy truck-mounted bridge. The TMM has advantages over the AVLB, which the Soviets also field. The TMM functions on softer ground and spans wider gaps than AVLBs. (The British Chieftain Mk. 6 spans the widest gap for an AVLB—20-meters). The truck-mounted TMM is lighter, and still puts out a class 60 bridge. TMM sections can be joined to form a 40-meter span—the job takes 45 to 60 minutes in daylight, 60 to 80 minutes at night. Each regimental engineer company has a four-vehicle set, each divisional engineer battalion has two (six per division total).

GMZ—self-propelled, armored mineplow vehicle. Based on the SA-4 GANEF chassis, the GMZ carries 208 antitank mines. It can bury four mines a minute, 4 to 5.5 meters apart. It reloads in 12 to 15 minutes. The GMZ is held by sapper companies in divisional engineer battalions.[3] GMZs are the core of divisional POZs, and probably work closely with divisional antitank assests like the MT-12 100 millimeter antitank gun.

IPR—underwater reconnaissance vehicle. Apparently based on the 2S1 122-millimeter, self-propelled howitzer chassis, the IPR is thought to have internal ballast tanks and cowled propellers that enable it to move across the bottom of water obstacles. Its 10-meter snorkel and pennants allow it to mark lanes. The power operated shovel-like device on the hull front may enable it to take river-bed and bank samples. No basis of issue is yet known, but IPRs might be used in the reconnaissance platoons of divisional engineer battalion headquarters companies.[4]

UR-77—tracked self-propelled line charge vehicle. Rocket-propelled line charges are a rapid mine-clearing method; the best known of these is the British Giant Viper. The UR-77 is a dedicated line-charge vehicle that appears to be based on a 2S1 chassis. A photograph published in 1983 in Steven J. Zaloga's *Soviet Tank Today* shows a 2S1-like vehicle with a rocket-propelled line charge being fired, apparently in Czech service. If this is the UR-77, it may replace the BTR-50K line charge first identified in 1974.[5]

Force Modernization

The recent appearance of the MT-T tracked transporter has led to a number of new engineer vehicles. The MT-T has the T-64 tank suspension and the late model T-72 engine. It appears to be a heavy artillery prime mover, like the older AT-T family. A new BAT-2 combat dozer (replacing BAT and BAT-M), a new PTS-2 tracked amphibian (replacing MDK-2 and MDK-2M) have already appeared with the MT-T as foundation.[6] Since the IMR combat engineer tractor is based on the obsolescent T-55 chassis, an IMR-2 may reasonably be expected to appear before long.

A new bridge family, the Amphibious Bridging System (Tracked) or ABS(T) recently appeared in the Group of Soviet Forces, Germany (GSFG). Dual pontoons mounted on a tracked amphibian chassis fold out before the vehicle enters the water, where it can link up with other ABS(T) units to form bridges or rafts.[7] The ABS(T) may be a replacement for the PMP ribbon bridge, the GSP heavy ferry, or both.

Clearly, the Soviet engineer forces

Notes

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[1] David C. Isby, *Weapons and Tactics of the Soviet Army*, Jane's, London, 1981, p. 331.

[2] Isby, pp. 331-43.

[3] "GMZ Tracked Minelayer," *Jane's Defense Weekly*, vol. 2, no. 5, 11 August 1984, p. 187.

[4] "IPR Amphibious Engineer Vehicle," *Jane's Defense Weekly*, vol. 3, no. 3, 19 January 1985, p. 99.

[5] "New Soviet Transporters," *Jane's Defense Weekly*, vol. 6, no. 1, 12 July 1986, pp. 18-19. Stephen J. Zaloga, *Soviet Tanks Today*, Tanks Illustrated No. 4, Arms and Armor Press, London, 1983, p. 42.

[6] "New Soviet Transporters."

[7] "New Soviet Amphibious Bridging System," *Jane's Defense Weekly*, vol. 6, no. 2, 19 July 1986, p. 70.

field an impressive array of specialized equipment. Some of the systems offer capabilities not matched by the NATO armies' engineer assets. The challenge to the west is manifold. We must ensure that our current inventory of equipment can be used to its full capacity. We must design, test, and deploy new systems to enhance the engineer contribution on the AirLand battlefield. And we must field a capable, well-trained engineer force that mans well-maintained and skillfully operated equipment.

SFC Peter L. Bunce is the Squadron Intelligence Sergeant for 2d Squadron, 3d Armored Cavalry Regiment.

Comparison of Soviet and NATO Specialized Engineer Equipment (less militarized civilian equipment)

Type Equipment	Soviet	US	British	West Germany	French
Armored Vehicle Launched	MTU-20/MTU	M60A1 AVLB	Chieftain AVLB Mk. 6	Biber	AMX-13 AVLB/PAA
Truck Launched Bridge	TMM/KMM				
Armored Engineer Tractor	IMR	COV (prototype)	FV180 CET	Pioniere-panzer 1/2	VCG/EBG
Combat Engineer Vehicle (Demo Gun)		M728 CEV	Centurion Mk. 5 AVRE		
Ditching Machine (Narrow)	BTM-3/BTM-TMG				
Ditching Machine (Wide)	MDK-2M/MDK-3				
Combat Dozer	BAT-M/BAT-2	M9 ACE			
Wheeled Dozer	PKT			ZD-3000	
Floating Pontoon Bridge	PMP	Ribbon Bridge		Ribbon Bridge	PFM
Self-propelled Ferry	GSP				CEFA
Tracked Amphibious Transporter	K-61/PTS-M/PTS-2				
Self-propelled Bridge/Ferry	ABS(T)	MAB	M2		MAF-1/2
Underwater Reconnaissance Vehicle	IPR				
Vehicle-mounted Mine Detector	DIM/DIM-3				
Towed Mine Plow	PMR-3	M57	Bar Mine Plough		
Self-propelled Mineplow	GMZ				
Self-propelled Line-charge Vehicle	BTR-50K/UR-77				
Towed/Dragged Line Charge		M57	Giant Viper		
Helicopter Minelayers	HIP Mine Chutes	M56			
Mine Scatter System		M128 GEMSS	Ranger	M548GA1 MiWS	
Mine Roller System	KMT-5	Tank-mounted Mine Roller			
Mine Plow System	KMT-4/6	Track-width Mine Plow	Mine Plough		
Tank-mounted Dozer Blade	BTU	M60A3 Dozer	Chieftain Dozer		

The one-hour minefield

a rapid drill for combat engineers or mechanized infantry

by CPT Philip L. Reed

The maneuver force commander points to a spot on his map. "We need an obstacle here," he tells the engineer. Their objective—to block the primary high-speed armor avenue of approach into the force—can best be met by a large minefield.

But there are problems. This engineer has never seen a helicopter-delivered M56 mine dispenser. His battalion's M57 mine plow is useless in mud or frozen ground. Besides, it's rusted and parts aren't available. Those high tech mine systems he was taught at school aren't available either. The reality? His platoon must lay mines by hand, and doing the job according to doctrine takes time—lots of time.

Combat engineers must meet such problems with methods that bring them up to speed with the maneuver forces concept of mobile armor warfare. The rapid minefield-laying drill that follows is a response developed by personnel of B Company, 16th Engineer Battalion. It gives any mech/armor division rapid mining capability. Using this method, troops in M113 armored personnel carriers can emplace multiple belts of surface-laid antitank mines.

THE TASK

Emplace a 1,000-meter front minefield in 1 hour or less

Conditions. Day or night. Any environment. Driver track commander (TC) buttoned up. Mission received and troop leading procedures initiated. Given a mechanized combat engineer platoon and its organic assets.

Standards. Minefield front, 100 meters. Minimum linear density .5,0,0 (at least one antitank (AT) mine per 2 meters of front). Rows must be a minimum of 8 meters apart at every point, and minefields must be marked on all four sides (NATO requirements). Minefield must be emplaced within 1 hour of arrival at the target site.

Resources. Four M113 APCs with radios, each manned by a driver, TC, and two mine handlers, and supplied with 145 M15 heavy AT mines, a 10-meter length of rope, cargo tie-down netting, DR-8 spool with 1,500 meters minefield marking tape, and minefield marking poles and signs (20 each), and a 3-pound hammer from the hand emplaceable minefield marking set (HEMMS).

PREPARE

Load vehicles

The engineer platoon assembles at the engineer company forward supply point (FSP), and prepares the platoon APCs. All equipment normally carried inside the vehicles, including seats, is removed.

Arm, place on safe, and load the 145 M15 heavy AT mines in each vehicle. Stack the mines along the right side wall and the front wall behind the driver and engine compartment. Secure the mines with netting, if available. Careful stacking and driver awareness reduces the risk of mines slipping during movement.

Once the APCs are manned, remaining platoon personnel and equipment remain with the engineer company FSP, or proceed to construct other obstacles.

Perform reconnaissance

The platoon leader may conduct a reconnaissance of the target area in one of the platoon's other vehicles or conduct the recon when the platoon arrives at the target rally point (RP).

Make a final check

In addition to the spool and other optional minefield marking materials, the crew must have the 10-meter length of rope to trail behind the APC, measuring the distance between mines.

Move

The platoon moves to the rally point near the target, conducts final checks, and deploys to the minefield edge. The orientation and limits of the minefield are determined by the leader's initial recon.

EMPLACE THE MINEFIELD

Step One: Position the vehicles

Keying from vehicle 1 (platoon leader), vehicles 2, 3, and 4 follow at a 20- to 30-meter interval, then turn and halt (figure 1). Remember, the minimum distance between rows at any single point is 8 meters.

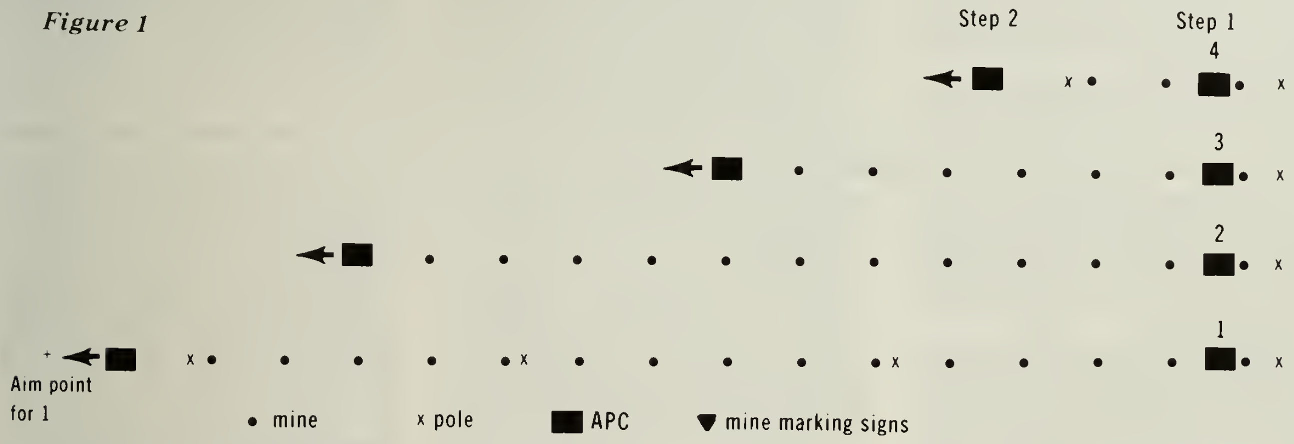
At the halt, without commands, a soldier in each APC emplaces one pole, drops the 10-meter rope (tied to the towing pintle) from the rear door, arms and lays the first mine. Each mine is placed by a mine handler sitting just inside the rear hatch. The ramp always remains in the closed position.

Step Two: Lay mines

Platoon leader in APC 1 slowly drives forward, (2 to 3 miles per hour). Other APCs follow, keeping the 20- to 30-meter interval. Each vehicle places its next mine when the end of the trailing rope reaches the previously emplaced mine. Perfect alignment is not necessary or desired. Drivers of vehicles 2, 3, and 4 align from the vehicle to the driver's left.

Vehicles 1 and 4 place intermediate poles approximately 50 meters apart, depending upon terrain (figure 1). This marks the front and rear edge of the minefield and is necessary for later marking. These poles, along with the end poles, identify the minefield limits in high grass or darkness. When necessary, directional lights from a HEMMS can be attached to the poles.

Figure 1



Step Three: Mark

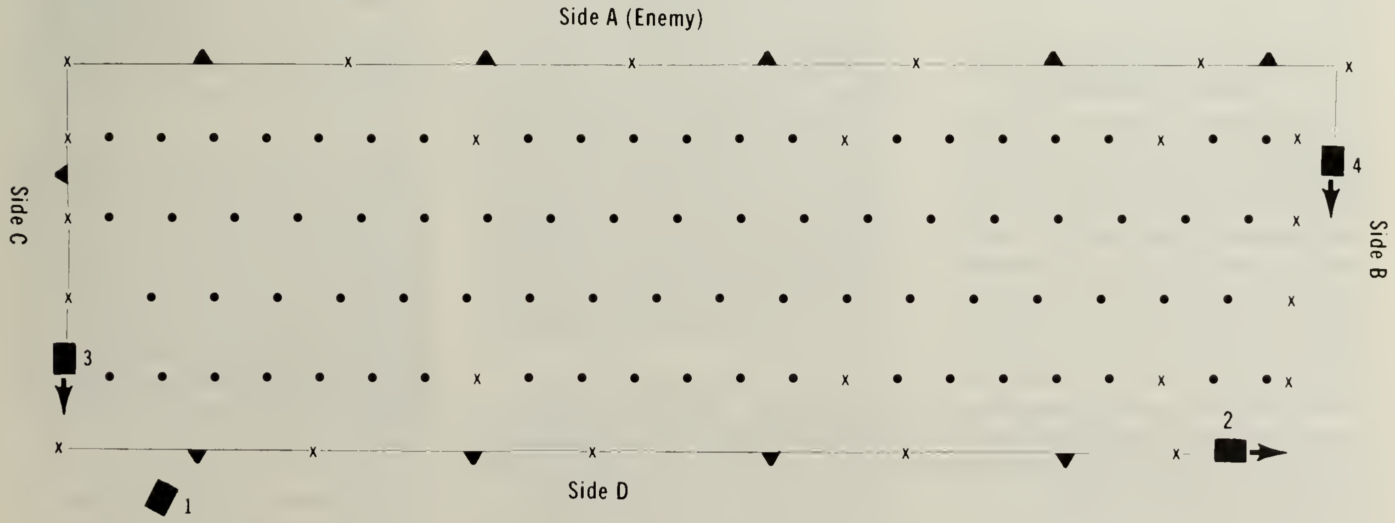
When the APCs reach the far side of the minefield, the platoon leader halts, waits for all other vehicles to come on line and halt, then orders "MARK." All four APCs then place one pole.

The platoon leader in vehicle 1 moves to the best position for observing the other vehicles, and records the minefield on DA Form 1355, Minefield Record.

Vehicle 2 moves and marks side D (figure 2); vehicle 3 marks side C; and vehicle 4 marks sides A and B. A fence is thus created by planting a pole, attaching marking tape to the poles, and slowly driving forward while reeling out tape. The APC halts to emplace minefield marking signs on the tape at 50-meter intervals. The handlers never dismount.

Drivers and TCs watch the minefield boundaries to ensure the fence is offset 15 to 20 meters.

Figure 2



(Continued on next page)

TRAINING NOTES

If there is enemy contact during emplacement, all vehicles exit the minefield, driving straight ahead, and assemble at the platoon RP.

To counter Soviet line charges and breaching techniques, lay multiple belts, thus extending minefield depth.

Install antipersonnel mines later, if time and situation permit. The M21 heavy antitank mine (tilt rod) is not usable for this method, because it must be buried. Tilt rod mines can be emplaced later if the situation permits.

To make lanes and gaps, halt the vehicles and place marking poles, or dismount later and clear mines from the lane by hand.

Testing has shown that mines do not fall in neat rows as would be expected. Variations of speed, terrain, intermediate marking, and driver visibility ensure a random dispersion of mines and, more important, at least one AT mine per 2 meters of front.

SUCCESS IN THE FIELD

This drill was tested for 4 months culminating in a 14-day operational test at Hohenfels Training Area in March 1984. The results were excellent. Troops could emplace and mark extended front minefields during periods of limited visibility, regardless of ground conditions. Units used concrete mines about the size and weight of the M15 AT mine. Surface-laid mines proved hard for buttoned-up armored vehicles to detect in tall grass, at night, or—painted white—in snow.

This simple method uses only TOE equipment and requires no modifications or fabrications. Experienced teams can do the job in under 20 minutes. When time is short and an obstacle is urgently needed, this method may be the answer.

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A Personal Viewpoint (continued from inside front cover)

increase minefield breaching capabilities; however, all these systems are developmental. Defense budget constraints may put them on hold for several years.

Small wonder maneuver units at the NTC are often destroyed while negotiating obstacles. As they are now organized, engineers can't effectively conduct assault breaches with current equipment.

Current doctrine dictates that assault breaches will be made by coordinated and rehearsed actions of task-organized support, assault, and breaching forces. Yet these forces are not currently task-organized into a standard obstacle breaching team (the Counter Obstacle Team).

THE COUNTER OBSTACLE TEAM CONCEPT

The Counter Obstacle Team is a combined arms force made up of assault, support, and breaching forces.* In a typical COT scenario, an attacking task force is led by scouts, followed by an armor company, the breaching force, and successive maneuver units. The size and types of units are METT-T dependent.

Obstacles are reconnoitered by scouts. If no bypass is available, then maneuver forces assume various roles. The lead tank company becomes an assault force and secures the far side by direct fire. The second maneuver unit (in this case the mechanized infantry company) becomes a support force providing overwatch fires for the breaching force. The breaching force is commanded by an engineer platoon leader or the tank company XO. This task organization must be automatic and precise. It can only be achieved if the assault, support, and breach forces are predesignated, well-rehearsed, and ready to be task-organized into the COT.

The COT ably negotiates complex obstacle systems with current organizations and equipment. Using a CEV for assault breaches, AVLBs for tank ditch crossings, and three engineer squads, the engineer platoon can function successfully. However, the CEV is not a minefield-breaching panacea. More able engineer equipment is needed if the COT concept is to be fully exploited.

The engineer slice of the entire Counter Obstacle Team can easily accommodate equipment currently in development. As the ACE, MCLIC, COV, ROBAT, rollers, and mine plows become available to augment the COT, the makeup of its engineer component can be adjusted to fit METT-T.

The combined arms team is currently ill-prepared to negotiate complex obstacle systems in stride. The Counter Obstacle Team concept, achievable to a limited degree with current assets, is an effective method of obstacle reduction. No time should be wasted—if we adopt the COT concept as AirLand Battle doctrine, we can make engineer mobility forces combat ready TODAY.

CPT Frank J. Smith is currently assigned to the III Corps staff at Fort Hood, Texas. He received a BA from Texas A & M University in 1982, and is currently pursuing an MS degree. A graduate of EOAC, CPT Smith has served as a line platoon leader and MCM platoon leader and as the assistant S3 in the 17th Engineer Battalion, Fort Hood, Texas.

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* The COT concept (or a resemblance thereof) has been used by the following organizations: 17th Engr Bn, 2d AD, Fort Hood; 16th Engr Bn, 1st AD;, Federal republic of Germany (FRG); 12th Engr Bn, 8th ID, FRG; 23d Engr Bn, 3d AD, FRG; 10th Engr Bn, 3d ID, FRG.

Past in Review **(continued from page 37)**

in the 46th Army part of the Southwestern Front. In the area of the LXVI Rifle Corps, 12th Army massed some 300 combat engineers with the first assault detachments.

THIRD PERIOD
1944 to 1945:
Expanding Offensive Operations

In the final year of the war, Soviet engineers refined and expanded their reconnaissance and crossing operations.

Crossing the Narew and the Oder

To prepare the Narew crossing, engineers assessed German defenses, collected data on enemy crossings, and searched for suitable crossing points. They passed their findings to the armies along with aerial photos of the western bank.

Using this information, the 48th Army's chief of engineer troops issued a diagram of the Narew to corps and divisions and assigned engineer reconnaissance subunits to specific areas. Reconnaissance platoons from the 399th and 73d Rifle Divisions detected minefields and barbed wire and marked possible approaches to the river.

Meanwhile, four engineer reconnaissance platoons from the 57th Combat Engineer Brigade and a platoon of the 104th Ponton Bridge Battalion, under covering fire, surveyed the river for both a low-water and a floating bridge site, and for raft crossings. Close and continuous cooperation between the chief of the engineer troops and the chief of the Army intelligence section ensured the operation's success.

During the Berlin Operation, combat engineers in the Second Belorussian Front Zone studied two channels and a swampy flood plain of the Oder. They found crossings and concealed approach routes, set up a network of observation posts, and swept for minefields. They made 41 measurements of both channels, established 67 bridges, crossings, and fords, and discovered 23 minefields and 11 pillboxes. As a result, they provided 19 routes for troops and 8 canals for moving rafting equipment to the West Oder.

Conducting deep reconnaissance

Behind-the-lines reconnaissance was standard in the engineer repertoire of support to the Soviet offensive, and the latter period of the war saw engineers intensify their scrutiny of enemy defensive lines. As successful operations opened the way, commanders began to send combined arms and engineer reconnaissance groups deeper into enemy positions.

To prepare for the Uman-Botosani Operation (4 to 9 March 1944), the staff of the engineer troops of the 27th Army, Second Ukrainian Front, sent out a reconnaissance group from the 6th Assault Combat Engineer Brigade. This unit penetrated over 15 kilometers behind enemy lines and found 6 fords and 26 bridges for troop crossings.

Such activities were essential to the massive offensives of 1944 and 1945, like the Bagration or Oder-Vistula operations, which featured high rates of advance. In these months, the Soviets proved their ability to take full advantage of weaknesses in enemy defenses by penetrating lines and carefully preparing for the advance. The success of Soviet exploitation and pursuit depended on accurate engineer intelligence.

Exploiting mobility

Motor and air-dropped mobile engineer reconnaissance units also proved valuable. In the Vistula-Oder Operation (January and February 1945), motorized combined arms and engineer reconnaisance subunits moved ahead of advancing troops to capture and hold crossings until forward detachments arrived.

Similar operations took place elsewhere. The 13th Army reconnoitered with mobile engineer detachments along the First Ukrainian Front, while chasing the enemy to the Oder. Before other forces arrived, a detachment of two truck-mounted companies from the 281st and 282d Combat Engineer Battalions reached the river with 13 pontons and set up crossings.

LEARNING FROM THE PAST

By the end of the war, the Soviets had reorganized and integrated engineers as an effective component of their combined arms team. While the war continually expanded in scope and pace, the Russians expanded engineer effectiveness and added, refined, and elaborated techniques. They mastered river-reconnaissance procedures. They used engineer troops for in-depth reconnaissance of positions behind water obstacles. They exploited aerial photography data. They cooperated closely with combined arms teams for successful river crossings. Repeatedly, the Soviets demonstrated a capacity to identify opportunities and exploit them to the fullest.

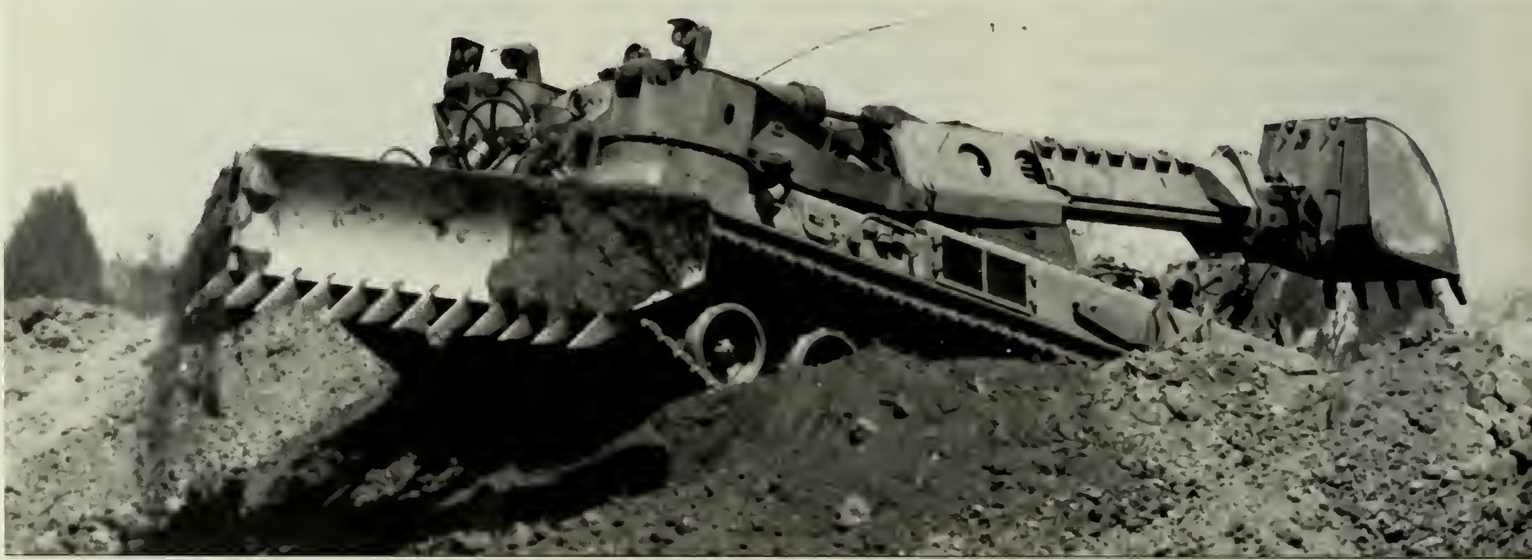
The current edition of the Soviet's *Combat Engineer Support* bases doctrine on these successful methods, illustrating each doctrinal principle with examples from the various battles. United States Army Field Manual 90-13, *River Crossing Operations,* 1978, lays out essentially the same doctrine for United States Engineers. However, the U.S. manual does not draw on the excellent resource offered by historical examples.

Our soldiers could usefully supplement FM 90-13 by studying both Allied operations and the engineer operations that led the Soviet advance across Europe. Such study would enrich U.S. engineers' practical knowledge of operations on similar terrain. It would teach another lesson too: the Soviet Army's record of imaginative, flexible, engineer responsiveness in the Great Patriotic War demands our close attention.

Note: Additional readings on Soviet Engineers can be found in the "Military Affairs" subseries, in the USSR Reports series prepared by Joint Publications Research Service (JPRS) and Foreign Broadcast Information Service (FBIS). These are available through NTIS and post/school libraries. Peter Vigor's *Soviet Blitzkrieg Theory* gives a useful picture of Soviet military doctrine and thinking.

Dr. Barry Fowle is a historian in the Office of History, Office of the Chief of Engineers. After 23 years of service, he retired from the Army as a lieutenant colonel in 1971. Dr. Fowle holds a PhD in history from the University of Maryland.

Testing engineer equipment at Fort Knox



The counter obstacle vehicle breaches an antitank ditch.

by LTC David S. Barber

"... and testing was conducted at Fort Knox, Kentucky." You've seen this phrase many times in articles about new engineer equipment. But why is the Home of Armor testing engineer equipment?

Engineer user testing at Fort Knox serves a vital function in the acquisition process. It gives the decision maker and the combat developers information on how a typical engineer unit and engineer soldiers will use a new system on the battlefield.

Both concept evaluation program tests (CEPs) and operational tests (OTs) are conducted by engineer officers and NCOs in the Armor and Engineer Board. These majors, captains, E7s, and E8s ensure that all the issues of the tests are completely and candidly addressed.

The test schedule is arduous. A typical test lasts two or three months, and test days may be 24 hours long. Proper test execution requires extensive coordination for troop support, facilities, supplies, vehicles, testing areas, and ranges. Recent TOE troop experience is desirable for both the officers and NCOs. They must lead and motivate their soldiers, acting as company commanders and first sergeants during the tests.

Soldiers are a key part of user testing, since their performance indicates the system's utility on the battlefield. Their comments and suggestions about systems weigh heavily, and are included in the test report.

Realistic Testing Available at Knox

Although not collocated with the Engineer School, Fort Knox is an excellent testing environment. The 194th Armored Brigade provides invaluable support, and can offer a combined arms scenario for testing. Also at Fort Knox are the 19th Engineer Battalion (Corps Combat), the 522d Engineer Company (organic to the 194th), and the 13th Engineer Company (Construction Support).

These units have supported engineer testing by providing player troops, constructing obstacles, and performing other engineer missions. They also supply TOE vehicles such as the M-1 and M60A3 tanks, Bradley fighting vehicles, heavy expanded mobility tactical trucks (HEMTT), and high mobility multipurpose wheel vehicles (HMMWV).

Fort Knox contributes the organic capabilities of the combined Boards as well. The Armor and Engineer Board's carpentry, metal, electrical, and machine shops can fabricate many items to support testing. In fact, the remote obstacle breaching assault tank (ROBAT) was first fabricated at the board, and its concept demonstrated in 1981.

User goals are the standard

Fort Knox's tests are based on user goals. They are designed to reduce the risk surrounding the decision to acquire or reject equipment or systems. Does a badly needed item constantly break down?—then it is more a liability than an asset. What if the equipment can do the job, but is so complex that many soldiers cannot operate or maintain it? The decision maker must determine whether equipment can be fielded or must undergo more development. Millions of procurement dollars are at stake, as are urgent needs for equipment in the field.

User tests at Fort Knox put typical TOE soldiers into a new system, then examine its performance in scenarios that replicate combat missions. In such settings, the unforeseen often begins to occur.

Here's a typical instance: During

a mine-dispensing test, a radio remote control device failed to perform as expected. When normal maintenance procedures couldn't correct the problem, the contractor took the item for repair. The fault proved to be mud on the remote control device. The contractor's recommendation?—*inform all test players that the device must be kept free from dirt and mud!* Since dirt and mud can't be eliminated from the battlefield, only two choices remained: redesign the item to function properly in field conditions, or reject it as unusable.

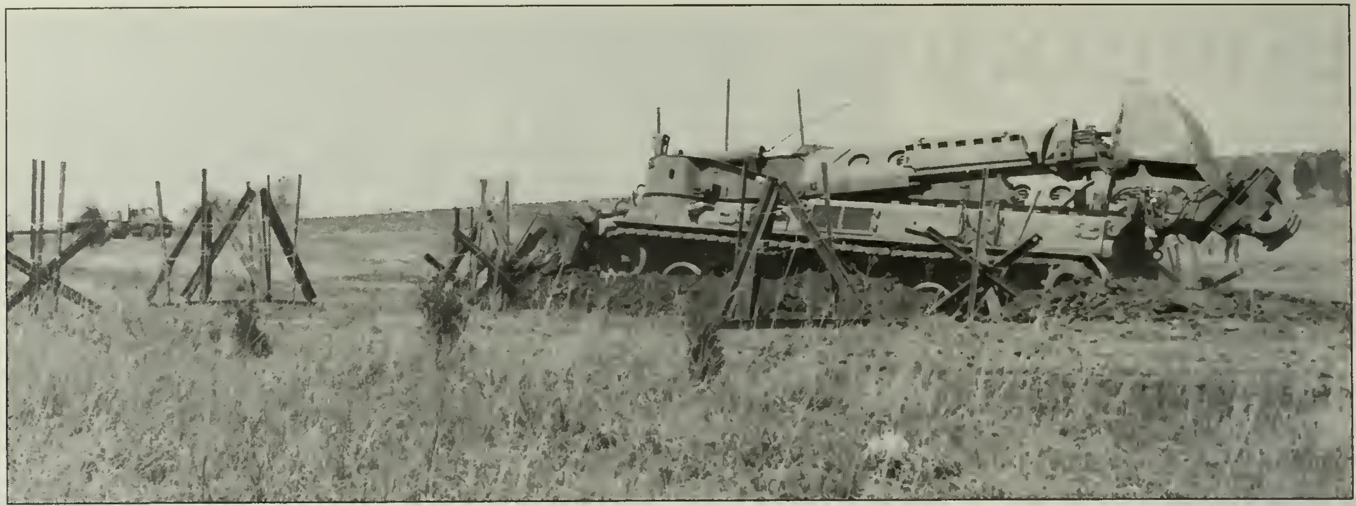
The Concept Evaluation Program

The CEP test determines whether a system actually works as envisioned. It should occur early in the acquisition cycle. Prototype equipment can be modified if testing indicates the need for changes. The concept of employment can be altered if different scenarios point to better methods.

When soldiers are brought into the CEP, equipment can be designed and modified to fit their capabilities, enabling them to make the equipment yield its expected performance. Contractor representatives often train troops on the new systems. Thus the contractor can easily

Sappers of the 522d Engineer Company use the auger attachment to bore holes for cratering charges, in tests of the Canadian M113 specially equipped vehicle.

Engineer soldiers in MOPP 4 test procedures for mounting the GEMSS Flipper on an M113 APC.



A COV breaches steel obstacles during a concept evaluation test.

identify minimum standards for the system and write them into the requirements document that will support funding for the project.

Last spring, a CEP was conducted for the counterobstacle vehicle (COV). Combat engineers are acutely aware of the need for such a vehicle. The capability to breach complex or compound obstacles consisting of mines, ditches, wire, and urban rubble from a protected platform has long been desired. However, the type of vehicle and appropriate attachments, crew size, and operation were still unknowns.

Working closely with engineers and technicians from Belvoir Research, Development, and Engineering Center, a CEP was conducted at Fort Knox in 1986. The prototype vehicle demonstrated that a compound obstacle could be successfully breached from a closed-hatch armored vehicle. The prototype also proved able to construct vehicle fighting positions, tank ditches, and combat trails through heavily wooded areas.

The CEP showed, however, that major design modifications are needed to improve visibility from the COV and to deal with its 74-ton weight. The Directorate of Combat Developments, USAES, is evaluating the results of this and other tests to determine the exact configuration required.

A CEP can also be used to evaluate a concept developed by another country. Last July, a modified Canadian M113 specially equipped vehicle (SEV) underwent CEP testing. To increase sapper efficiency, especially at the squad level, Canadian engineers have modified their M113 squad APC by adding hydraulic tools. The tools are powered by a hydraulic pump that works on direct drive from the M113's engine. Using the power tools, squads can complete engineer missions in a shorter time with less manpower.

The Operational Test

The OT is designed to test the operational suitability, military utility, and operational effectiveness of a system—in other words, the hardware, software, training, maintenance, and logistics of the system. The OT test is a dress rehearsal that usually occurs just before a type classification decision is made. System development should be mature by this time, and any modification must be made on the actual production model.

The GEMSS auxiliary mine dispensing system (FLIPPER) test completed in March 1986 shows the benefits of an OT. The test was designed to verify the reliability, availability, and maintainability (RAM) characteristics of the system. The RAM tells the decision maker how much of the time the system will be available to the unit and how often it will be down for maintenance.

Each test followed the mission profile conceived by the Directorate of Combat Developments, USAES. In this case, the tests required FLIPPER to dispense 360 to 400 mines in three belts 1,000 meters long. Missions were conducted in MOPP 4, cold weather clothing, and normal field uniform, both in daylight and at night. Four different vehicles were used: the M113 APC, 5- and 2½-ton trucks, and the M548 tracked cargo carrier. Inert mines replaced actual M74 and M75 GEMSS mines.

After two weeks, numerous failures of the flywheel and tire assembly brought the tests to a halt. The material developer, US Army Armament Research and Development Command (ARDC), designed a new assembly and rushed it to Fort Knox. With the new assembly, over 12,000 mines were launched without a failure, and the reliability criteria were met.

The testing programs at Fort Knox thus make the Home of Armor an excellent combined arms testing ground that ensures adequate realism, and affords the opportunity to test new systems in both developmental and fine-tuning stages.

LTC David S. Barber is currently in the Program Managers' Course, Defense Systems Management College at Fort Belvoir. He was previously the Chief of the Combat Support Branch, Engineer Test Division of the U.S. Army Armor and Engineer Board at Fort Knox. He also served as the exchange officer to the School of Military Engineering in Sydney, Australia. LTC Barber is a 1969 USMA graduate, has a master's degree in mechanical engineering from Arizona State University. He is a registered professional engineer in Virginia.

Countermine operations in El Salvador

by MAJ James K. Waters

Vietnam taught us that mine and countermine operations don't always involve large barriers, sophisticated equipment, and highly trained emplacing and breaching teams. Instead, the enemy may harass and demoralize opponents with randomly placed mines and booby traps.

We changed to meet the countermine threat in Vietnam—changed tactical techniques, individual training, and equipment use. Unit leaders learned to disperse troops and select routes carefully. Soldiers learned to identify mines. Combat engineers learned to use existing equipment to locate mines. We met the Threat.

Today, countering small mines in a low intensity conflict must again become a priority. This article reviews a success in combat development—the countermine effort of the Republic of El Salvador Armed Forces (ESAF). Cooperation between ESAF and the United States Southern Command (USSOUTHCOM) has been the key to success. The results?—guerrilla mine warfare is less effective, and ESAF ground tactical operations are more successful.

Assessing the Threat

Salvadoran guerrillas find many uses for mines and booby traps—they employ them to terrorize civilians, deny access to guerrilla base camps, warn of approaching troops, restrict enemy movements, and slow or disrupt operations.

Most guerrilla-fabricated mines are made from materials like sheet metal, wood, plastic pipe, and commercially available chemicals.

Salvadoran trainer demonstrating mine sweeping to ESAF troops.

SFC Mark Goode inspects a White 6000 commercial metal detector with Salvadoran trainees.

Fabricators use a metallic blasting cap detonation system. It is unsophisticated, but extremely effective. So effective, in fact, that mines and booby traps account for 80 percent of ESAF casualties. Hundreds of civilians have also been killed, crippled, or maimed.

It is worth noting that captured guerrilla documents on mine and booby-trap employment were originally prepared in Hanoi—the guerillas still heed lessons taught by their Vietnamese comrades. Unfortunately, some countermine lessons we learned in the Vietnam conflict have faded from our institutional memory. To recapture these lessons, USSOUTHCOM planners used earlier versions of current manuals as a basis for ESAF doctrine, training, and force structure.

The Countermine Response

Cooperation between ESAF, USSOUTHCOM, Troop Support Command (TROSCOM), U.S. Army South, and the U.S. Military Group in El Salvador resulted in a successful countermine program for El Salvador.

A TROSCOM study identified equipment that could enhance ESAF's countermine ability. The TROSCOM team found that U.S. Army mine detectors (AN/PRS-7/8 and AN/PSS 11) could do the job, but required extensive maintenance. Since nearly all mines and booby traps used by the guerrillas contained some metal, TROSCOM suggested a commercial metal detector. The White 6000 detector proved a reliable, low-cost tool for detecting mines, and the Salvadoran government bought a supply on the open market.

The TROSCOM team also recommended protective clothing. Natick Laboratories, which develops U.S. Army individual clothing and equipment, quickly produced overboots designed to reduce blast effects, Kevlar "blast chaps" to reduce fragmentation wounds to the legs and torso, and clear-lensed goggles for eye protection (dark lenses obscure trip wires). Nearly all this gear is available from commercial sources.

Because the protective clothing weighs up to fourteen pounds, it is worn only when soldiers are sweeping areas known to be mined. Unless intelligence reports the presence of mines and booby traps, units rely on visual cues during routine patrolling operations.

The USSOUTHCOM provided training for the countermine program. U.S. Army South designed and produced realistic guerrilla-style mines and instructional charts, and the U.S. Military Group in El Salvador coached host country soldiers to become trainers. The trained ESAF officers and NCOs then returned to their units ready to teach mine recognition and self protection.

One ESAF infantry battalion took the lead as a test bed unit. This unit received intensive training on countermine operations and advanced patrolling techniques. Each company organized, trained, and equipped a three-man countermine team.

The team's operating concept is simple—When the unit enters a suspect area, the team is called forward and begins to sweep for mines. As mines are detected, they are marked and destroyed in place. No attempt is made to recover the mines—they are usually booby-trapped. These teams also use the metal detectors to locate hidden caches of supplies, weapons, and ammunition.

To gain an important psychological point, government forces have severely restricted their own use of pressure sensitive mines. The Salvadoran government informs citizens of the dangers and indiscriminate nature of guerrilla mines and booby traps, using radio and

Regimental Update

Former Engineer Named DMOC:

On 12 February 1987, letters were sent to the 353 Active and Reserve Component (USAR and ARNG) commanders of engineer commands, brigades, groups, battalions, and separate companies requesting nominations for Distinguished Members of the Corps (DMOC). The letters, signed by the Chief of Engineers, LTG Elvin R. Heiberg, III, requested one officer (active or retired) and/or one enlisted (active or retired) from each of the above-mentioned units be nominated as DMOC of the Corps of Engineers. DMOC nominees must have served in the Corps.

DMOC activities, spelled out in AR 600-82, *The U.S. Army Regimental System*, are ceremonial in nature and are intended to promote and enhance the history and traditions of the Corps. Examples of DMOC activities include: participating in award ceremonies, speaking on history and traditions at dinings-in, and other similar functions.

On 10 March 1987, at Fort Belvoir, Virginia, on the occasion of his farewell address to Engineer Officer students and faculty, General (USA Retired) Bruce C. Clarke was designated as the Corps of Engineers' first Distinguished Member. The presentation was made by the Corps' Honorary Colonel, LTG (USA Retired) Frederick J. Clarke. Participating in the ceremony were MG Richard S. Kem, USAES Commandant, and the Corps' Honorary Sergeant Major, Sergeant Major of the Army (USA, Retired) Leon L. Van Autreve. General Clarke, who was commissioned a second lieutenant of engineers in 1925, was cited for his long and close relationship with the Engineer School, as well as his distinguished career as a soldier, leader, and a statesman.

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television stations and newspapers. In response, civilians have begun directing police to mines and booby traps.

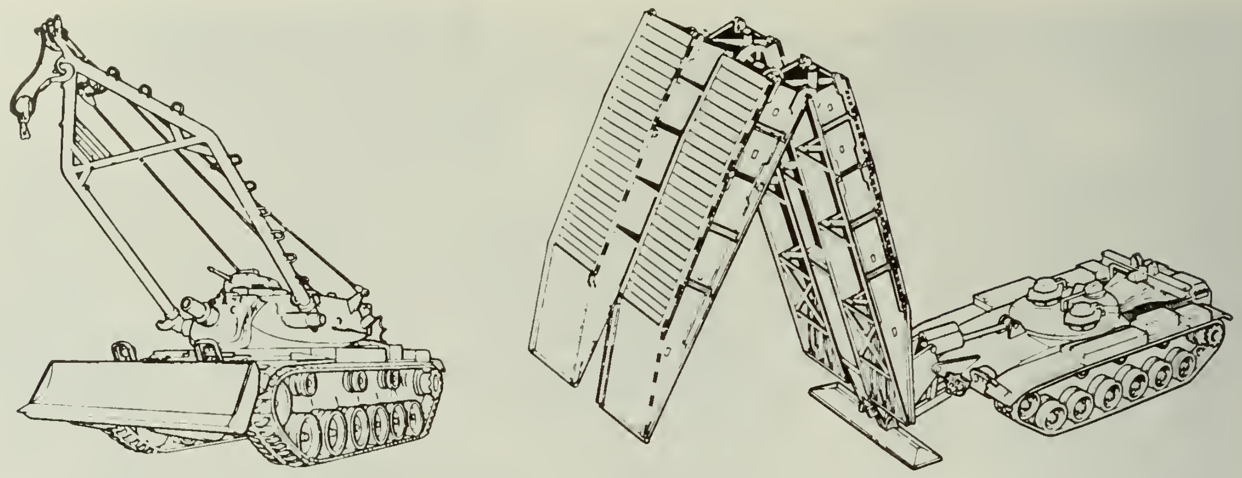
Perhaps the best means of limiting guerrilla mine warfare is interdiction of component materials or finished mines before emplacement. Thus, gathering information on mines is part of the intelligence collection effort. Both battalion and brigade intelligence officers emphasize enemy mine capability as an essential element of information (EEI). Police and military patrols are alert for this information. Police watch local markets to detect purchases of raw materials that might be used to construct mines and booby traps. Informers are also useful—on one occasion, an informer uncovered a cache of more than six hundred mines.

Results

The effectiveness of this countermine program is evident in the increased confidence and aggressiveness of units trained and equipped to fight the countermine battle. Test bed battalion soldiers now operate with little or no fear of enemy mines and booby traps. Casualties have fallen by nearly a third—only 5 injuries occurred in the last month of 1986. Moreover, the guerrillas seem to have lost prestige in the eyes of the civilian community.

The Salvadoran project has produced a wealth of information and technical data on countermine measures and equipment. The lessons learned in El Salvador can be applied in other areas of low intensity conflict. Both the host country and the United States are winners. The guerrillas are losing—losing prestige, losing ground, losing popular support.

MAJ James K. Waters is countermine project officer, Small Wars Operations Research Directorate, HQ SOUTHCOM. Before staff assignments to the National Guard Bureau and HQ, Army Materiel Command, he was Director, Plans and Training, Carlisle Barracks, and Commander, HQ Company, Army War College. MAJ Waters has served in Vietnam, in staff positions with the 8th Infantry Division in Germany, and with the 82d Airborne Division. He holds a BA in history from Methodist College, and is a graduate of OCS, Airborne and Ranger Schools, the Jungle Operations Course, and Command and General Staff College.



AVLBs/CEVs—Upgrading the Fleets

by MAJ William R. Fast

THE CHALLENGE

Both the M728 combat engineer vehicle (CEV) and the armored vehicle launched bridge (AVLB) have been fielded for more than 20 years, and will continue to support M60A3TTS tanks in reserve components well past their 30-year mark.

Yet these systems now strain to keep pace in maneuvers with the M1 Abrams tank and the Bradley fighting vehicle. They also have logistic problems. Fleets compete with newer equipment for maintenance support, and face directed reductions in PLL/ASL—parts, that is.

For 10 years AVLB/CEV readiness rates have often been below the M60-series tank. In today's Army of Excellence, this cannot continue.

TAKING ACTION

The Army intends to improve and maintain both systems until replacements are fielded. At the urging of the U.S. Army Engineer School, the AVLB and CEV are now readiness report pacing items in engineer companies. They are also targeted for an all-out readiness offensive in the Army Materiel Command.

Tank-Automotive Command (TACOM) and Armament, Munitions, and Chemical Command (AMCCOM) are fixing systemic wholesale level problems with the AVLB/CEV systems, while the Army Logistics Assistance Community helps engineer units solve immediate readiness problems. Their goal?—achieve and maintain the systems at 90 percent fully mission capable.

In 1984, the U.S. Army Materiel Command's Materiel Readiness Support Activity conducted a fielded system assessment of both the AVLB and CEV. Their findings, with ideas from a joint TACOM, Engineer School, and Ordnance School readiness working group, are the foundation of the readiness offensive. Several programs are now upgrading AVLB/CEV assets. They are—

Modification application plan (MAP)

By FY 1989, modification kits and application funds are expected to be available for applying compatible M48/M60-series tank improvements to AVLBs/CEVs. These modifications, shown in the table, enhance survivability, safe operability, and maintainability.

Overhaul program

Depot-level deficiencies qualify many AVLBs/CEVs for overhaul. TACOM's Combat Vehicle Evaluation Team identifies candidates in annual visits to each installation or major command. This year, TACOM programed ten AVLBs and twelve CEVs for overhaul in CONUS and USAREUR. To ensure responsive replacement, future overhaul schedules were designed to minimize overhaul turnaround time.

Request for assistance program

Some commands intensively manage equipment deadlined for over 30 days. TACOM's Director for Readiness validates and expedites repair parts to support this effort. Requests for assistance may be sent directly to Director of Readiness at TACOM by message, letter, or telephone. The supporting logistics assistance office will provide TACOM's response within 5 working days.

Other improvements

Improved training. Three military occupational specialties (MOS) are primarily responsible for operating and maintaining the systems. They

Product Improvements

Popular Name	Application on: AVLB	CEV
Clean Air	x	x
Armored Top Loading Air Cleaners	x	x
RISE Engine (IDS)*	x	x
Engine Smoke	x	x
Smoke Grenade Launcher Adapter Hardware	x	x
Driver's Night Viewer	x	x
Improved Vision Cupola	x	
Passive Night Vision		x
M240 Machine Gun (IDS)		x
Second Magnetic Brake (IDS)		x
AN/VSS-3A Searchlight		x
Automatic Fire Extinguisher System	x	x
Laser Protection	x	x
Secure Lighting (Unit)*	x	

*Improvements are applied by depot-level teams at installation or unit locations. Exceptions are unit-level maintenance *(Unit),* and *IDS* for intermediate direct support. TACOM depot maintenance division and installation modification work order coordinators cooperate to schedule modifications.

are MOS 12F, *Engineer Tracked Vehicle Crewman;* MOS 63Y, *Tracked Vehicle Mechanic;* and MOS 45N, M60A1/A3, *Turret Mechanic.* In addition to normal training patterns, improved instruction for these MOSs includes—

MOS 12F: The Engineer School offers a CEV skill performance aid for all crew positions. The Project Manager, Training Devices, will release CEV video disk gunnery simulators to the field in January 1988.

MOS 63Y: Beginning in FY 1988, mechanics will get 5 more weeks of training in basic automotive maintenance. This training should improve their ability to troubleshoot and diagnose problems.

MOS 45N: The Ordnance School is preparing an exportable training package for CEV turret repair.

Better technical manuals. All AVLB technical manuals have been revised to reflect product improvements through the MAP (see the table). Scissors bridge manuals will be revised in the near future. CEV maintenance manuals are now revised, and a total revision of CEV repair parts manuals has begun.

Improved bridge serviceability and repair. Until the scissors bridge technical manual is revised, a general repair procedure has been issued to field units. Depot-level repair procedures are being developed to return unserviceable panels and components to stock. The bridge will probably become reportable as a component of the AVLB under the next revision of AR 700-138, *Army Logistics Readiness and Sustainability.* This will give the bridge needed visibility at all levels of management.

Faster spares acquisition. Secondary spares for both the AVLB hydraulic launcher system and the scissors bridge were part of the Army's FY 1986 procurement of launcher mechanisms and bridges for the AVLB conversion program. This measure reduced costs and improved prospects for receiving quality items on time.

Uniform AVLB fleets. Many Active Army units have both M48A5 and M60A1 AVLBs on hand. Their suspension systems and automotive controls differ. To reduce logistical problems, AVLB fleets should be uniform at battalion level. Where possible, assets should be transferred to achieve uniformity. The TACOM AVLB Item Manager now coordinates issues of newly converted or overhauled AVLBs to avoid mixing the fleets.

Enhancing technical assistance. Selected TACOM logistics assistance representatives (LARs) in CONUS recently trained on AVLB/CEV operation and maintenance so they could better serve their units. In AMCCOM, they already monitor the status of M728 CEV turrets and provide unit-level assistance. Units should report any nonmission-capable supply parts requisitions to the supporting LAR. Maintenance assistance is only a phone call away.

COMMAND RESPONSIBILITY

Until now, we've focused on management efforts to improve AVLB/CEV readiness. There is, of course, another key player—the commander. Without command emphasis, efforts of AMC and TRADOC will be in vain.

Monthly reports by LARs show that readiness degradation is often caused by inadequate training and discipline. Here are the findings:

- Drivers and crews inadequately trained.

- AVLB/CEV operated with incomplete crew.
- Inadequate inspection of automotive systems.
- Improper use of diagnostic tools and gages.
- Poor troubleshooting, resulting in incorrect use of parts.
- Overworking vehicles, especially speeding or overusing CEV's blade.
- Infrequent operation and failure to exercise hydraulic systems regularly.
- Failure to perform organizational and support maintenance.

These deficiencies have been brought to the attention of the service schools. Still, increased emphasis on proper operation and maintenance procedures is needed at all levels.

THE FUTURE

Although new equipment is projected for the mid-1990s, the AVLB and CEV may have to fill the gap until the year 2000. Improvements in training, maintenance, supply, and command emphasis are keys to readiness. The 90-percent fully mission-capable goal can be met only if all concerned address their areas of responsibility. All engineer soldiers are challenged to do their part to keep the AVLB and CEV ready.

MAJ William R. Fast wrote this article while assigned as Assistant Project Manager, M60 Tanks, TACOM. He is currently a student at Command and General Staff College, Fort Leavenworth. MAJ Fast holds a BS degree in Engineering from Iowa State University and an MS degree in Systems Management from the University of Southern California. He is a graduate of the Ordnance Officer Advanced Course and the Materiel Acquisition Management Course.

Engineer Solution

1. Initial bridge length: Add the gap, safety setbacks, and roller clearances. Remember, since a panel is 10 feet long, the bridge must be built in 10-foot increments.

Gap		58 feet
Safety setbacks (prepared abutments)	Near side	3.5 feet
	Far side	3.5 feet
Initial roller clearance	Near side	2.5 feet
	Far side	2.5 feet

Initial bridge length

58 + 3.5 + 3.5 + 2.5 + 2.5 = 70 feet

2. Construction type:

Design load classification	60W/60T
Construction type	Double-single (DS)

3. Initial grillage type: Determine the actual soil bearing capacity (SBC). You may have to round down to a selected value. Note, always use grillage type 1 at a minimum.

	Actual SBC	Selected SBC	Grillage Type
Near side	5	3.5	1
Far side	5	3.5	1

4. Roller clearance: Determine the distance from the center of clearance of the rocking roller to the center of clearance of the base plate.

Near side	4.5 feet
Far side	4.5 feet

5. New bridge length: Remember, since a panel is 10 feet long, the bridge length must be rounded up to the nearest 10 feet.

58 + 3.5 + 3.5 + 4.5 + 4.5 = 74 feet or 80 feet

6. New truss type:

Triple-single (TS)

News & Notes

Composite bridge under development

The TROSCOM Fort Belvoir Research and Development Center has awarded a $6.1 million contract to Foster & Miller, Inc., of Waltham, MA, for the design, fabrication, and testing of a module, composite-material bridge which will be erected three times as fast, using far less manpower and equipment, as the dry gap bridge now used by the Army.

Composite materials are the new lightweight, high-strength materials of aramid fibers, carbon, and epoxy that have been used successfully in space and aircraft, as well as skis, tennis rackets, and the Army's new helmet.

In this design, composites will be used in the top and bottom chords, tensile tie rods, and traversing beam. A filament-wound, high-stability truss chord, made of high-modulus graphite fiber and epoxy resins, will form the main stress-carrying member and enable the bridge to support 70 tons over gaps 180 feet wide.

Use of these composites will result in a bridge 27 percent longer than the current standard medium girder bridge, but weighing 40 percent less. It will also cut necessary manpower from 33 to 6 and transportation needs from 14 trucks to 3 modified trucks.

The 60-foot modules of the future bridge will be carried and launched by trucks equipped with rollers and cranes. Each module will weigh 7½ tons and measure 20 feet by 7½ feet by 180 inches when folded for transport.

When they arrive at the site, the modules will be rotated 90 degrees and expanded. Because of their unique design, they will expand in two dimensions, providing bridge sections 60 feet long, 15 feet wide, and 80 inches deep. Joined by steel pins, the complete bridge will then be pushed across the traversing beam by a crane on one of the transports. Six men will complete the operation in 45 minutes, compared to the thirty men working 3 hours it now takes to erect the main girder bridge.

The contract calls for 240 feet of the experimental bridging to be delivered to the Center in 1989.

Solar energy technology counters battlefield detection

Troop Support Command's Research and Development Center, as part of its responsibility as the Army's leading laboratory for camouflage, has found a way to use solar energy technology to protect Army equipment from detection by thermal sensors.

Working in the Center's Countersurveillance and Deception Division, Richard Bulova developed the idea of using black oxides of nickel or chrome, substances used in solar collection panels, to reduce the amount of heat emitted by the exhaust systems of Army vehicles.

"I started working on this about a year and a half ago while I was doing some infrared studies," Bulova recalled. "I noticed that the easiest thing to find on a vehicle was its exhaust system. Enemy sensors could pick it up and use it to target or identify the vehicle. Then, I came across an article about the composites used as solar energy collectors. They retained heat rather than radiating it into the atmosphere. I got the idea of using them to plate vehicle exhausts."

Bulova started the work with the composites as part of the Center's in-house laboratory independent research (ILIR) program. Last year, as the first step, the Center awarded a contract to plate the exhausts of six 2½-ton trucks with black nickel. The tests have shown measurable reduction in the amount of heat given off by the trucks, which has persisted for over a year. Bulova estimates that it may be possible to reduce a vehicle's detectability by 200 percent. Evaluation will continue with three additional trucks this year.

Vendors have estimated that significant protection against detection could be provided for as little as $30 per vehicle.

Bulova recommends that Tank Automotive Command begin a product improvement program to incorporate these coatings into their standards where possible. He also recommends that the Center evaluate equipment currently under development for possible applications of this treatment.

Career Notes

NCO and Enlisted Soldiers Branch

MOS 51C Eliminated

All personnel holding MOS 51C, Structures Specialist, were converted to 51B, Carpentry-Masonry Specialist, in October 1986. Letters explaining the Army's rationale for this change were mailed in December 1986 and January 1987. Commanders and personnel officers should also have received these letters. If you are affected by this change and have not received your letter or desire further information, contact Enlisted Branch, MILPERCEN, AV 221-8329, commercial (202) 325-8329.

Enlisted Branch Hotline

For enlisted engineer career advice, call the Enlisted Engineer Branch hotline—AV 221-7150, commerical (703) 325-7150. When you are asked for the number of the person you are calling, dial 325-7710. Following the instructions you recieve, leave your full name and social security number. Your career advisor will respond the next day during normal office hours.

Changes in PCS Policy

In October 1986, the Army announced changes to its policy on permanent change-of-station moves. The primary focus of these changes is the reduction of PCS moves from one CONUS installation to another. Although other policy changes will soon be announced, it is anticipated that most CONUS personnel requirements will be filled by soldiers returning from overseas. Increased time-on-station requirements will slow down PCS moves. Overseas commands still have priority, so CONUS-based personnel volunteering for overseas assignments are unaffected.

Upcoming issues of ENGINEER may have a new look, as we make format changes to comply with new DA and TRADOC guidelines for professional publications. Our mission—to inform U.S. Army Engineers of current developments and emerging doctrine—will not change. Forthcoming issues will address—

- *General engineering support*
- *Engineer support to facilities*
- *Engineers in ARNG components*
- *Low intensity conflict*
- *Mine/countermine warfare*

We invite your contributions and your comments.

Past in Review

Soviet engineer support to river-crossing operations in the Great Patriotic War

by
Dr. Barry W. Fowle
Office of History, OCE

Much current Soviet combat engineering doctrine was forged in the crucible of the Great Patriotic War against Nazi Germany. As they defended their homeland, consolidated their forces, and drove home their offensive, the Soviets continuously revised doctrine and tactics.

The lessons of the war underpin Soviet doctrine today for good reason—they show a history of success. The Soviets answered the challenge of war flexibly and creatively even under difficult circumstances. They developed responsive, efficient organizational structures, and they added effective techniques to their repertoire as they fought. Just as the Russians continue to study the history of their achievements, we should attend to the lessons they value.

FIRST PERIOD
June 1941 to November 1942: Reorganizing

When the Germans invaded in 1941, the Soviet Army was ill-prepared to direct and conduct engineer combat operations in support of combined arms warfare. Nonengineer commanders often wasted engineer resources.

The Russians acted quickly to improve their situation, showing a capacity to respond flexibly under stress. Even as the Germans drove deep into their territory, they created an organizational structure that gave engineer officers more control over engineer forces.

The chief of Soviet Army engineer troops became a Deputy People's Commissar of Defense. Chiefs of engineer troops were appointed deputy commanders of fronts (Army groups), and staffs were set up for engineer troops in the fronts and subordinate armies. Once engineer officers took charge of engineer troops, they used resources skillfully and flexibly to support combined arms operations.

SECOND PERIOD
November 1942 to January 1944: Gaining Experience

After major successes at Stalingrad and Kursk, the Soviets pressed their strategic initiative across the many rivers that lay in the path of their drive toward Germany. Soviet Army engineers now acquired vast experience in assault crossings of major waterways.

Reconnaissance methods

As the army moved, principles for using and controlling engineer troops changed. Basic engineer resources were attached to combined arms formations and units, and a new engineer brigade organization improved command and control. The reorganized engineer staffs included reconnaissance specialists and an engineer plan for reconnoitering water obstacles.

Reconnaissance was a step-by-step operation. First, engineers studied maps, photos, and information from local residents, partisans, and prisoners. As troops approached a river, engineers determined its width, depth, current speed, and bottom conditions. They then chose crossing sites, gathered information on existing crossing structures, studied approach routes, and identified local crossing equipment and supplies of wood.

As Soviet engineers began to plan large-scale crossings, their reconnaissance expanded to take in entire operational areas. Each front collected information on rivers and passed it to subordinate units. Continuous movement through operational areas was now supported by comprehensive engineer plans that covered all rivers and major terrain features.

Crossing the Dnepr

The September 1943 crossing of the Dnepr proceeded with staged reconnaissance. First, the front's engineer troop staff compiled a file describing the river in the zones of the planned crossing. This file was issued to engineer troop staffs of the 6th and 12th Armies.

At this level, engineers reconnoitered both the river and the enemy. In the 6th Army zone, reconnaissance was made by subunits of the 62d Field Engineer and the 5th Ponton Bridge Brigades. Subunits of the 4th Ponton Bridge, the 11th Assault, and the 62d Field Engineer Brigades, and the 8th Ponton Bridge Regiment did the work for the 12th Army zone.

In the zone of the 7th Guards Army of the Steppe Front, engineers took an additional step. Because demolition of the Dnepropetrovsk hydropower plant had diverted the Dnepr's channel in 1941, aerial photography and air reconnaissance examined the channel's new course.

As a final preparatory step, engineers chose sites for three floating bridges and one low-water bridge. They also pinpointed enemy positions and established routes for moving troops to crossings.

Combat engineers served in the forefront of the Dnepr crossing. A squad of engineers opened minefields on the far side of the river with the support of submachine gunners

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Engineer

v. 17
no. 2

OR ARMY ENGINEERS

PB 5-87-2 (TEST)

Our jobsite—the world...and beyond

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Let's Improve Engineer Command and Support Relationships

by MAJ Nicholas J. Buechler

Engineers must take a more active role in showing the maneuver commander how engineers can—and cannot—support AirLand Battle. We must understand the different command and support relationships and when to apply them.

Engineers need to know more than by-the-book definitions of each relationship. We can't let the sterile artificiality of war-game environments deceive us—AirLand Battle is certain to be more complex than any game. Yet doctrine in FM 5-100, *Engineer Combat Operations,* doesn't give adequate flexibility to engineers supporting the defense at battalion task force level.

AirLand Battle's prime mandate is this—***seize every opportunity to take the offensive, even in a defensive mission.*** Yet engineer assets are usually placed in a direct-support role for defensive missions. This sets engineers at odds with the offensive spirit of AirLand Battle. Why?—because doctrine says engineers placed in direct support can't be further task organized—and under these conditions, they can't respond flexibly to counterattacks.

The result is that engineers in the field sometimes ignore doctrine and support the maneuver commander as best they can. They do what they are taught to do at the Engineer School—task organize on the basis of METT-T.

This doctrine-flanking maneuver isn't good enough. Engineers must be smarter task organizers; our doctrine must be better defined. We should start by determining task organization according to a prioritized set of critical factors.

1. Serve the commander's intent—know his priority of effort, his concept of operation, his scheme of maneuver, his plan for defeating the enemy. Shape all efforts to his goals.
2. Allocate engineers based on needed effort—prioritize allocations according to critical missions: mobility, countermobility, survivability, and general engineering.
3. Assign missions to engineer units that can best carry them out—units with the right capabilities and equipment.
4. Preserve the engineer unit's normal association with a supported element whenever possible.
5. Consider the needs of follow-on missions—keep task organization simple and clean. Prevent complications in multiple phase operations.
6. Evaluate logistical support—the maneuver unit's ability to support engineers and the benefit gained from that engineer support must be weighed.

The successful maneuver commander applies the ten imperatives of AirLand Battle. The engineers support him. If the maneuver battalion commander is to conduct a successful brigade-directed counterattack or local counterattack, he needs to control engineer assets directly. The engineers must be in a command relationship with the maneuver commander, and allocated attached or under operational control to the task force.

This does not mean that engineer forces must be attached or OPCON to every maneuver battalion. Quite the contrary. If the engineer mission can be accomplished at brigade level, then retain control of engineer forces at that level. Maximum power can be built on the AirLand Battlefield only if direct- or general-support relationships are kept above brigade level.

If we become more proactive in expressing our capabilities, maneuver commanders will quickly stop task-organizing engineers down to squad level or committing vital engineer assets as infantry.

The real problem is that we hamper the maneuver commander by defining support relationships too tightly. Then the commander can't further task organize his engineer forces. We must provide him more flexibility, better guidance, and recommendations on engineer employment.

The advent of E-Force will bring more effective engineer support to the maneuver task force commander. The normal associations built into E-Force promote better command and control relationships and reduce the need to form ad hoc engineer task forces. It will also promote the attachment of engineers at brigade level. Until E-Force is fully implemented, engineers supporting task force level operations must be placed in command relationships.

MAJ Nicholas J. Buechler is a team leader for EOAC at the U.S. Army Engineer School. He has served with the 12th Engineer Battalion in West Germany, and with the 5th Engineer Battalion at Fort Leonard Wood, Missouri. MAJ Buechler holds BS and MS degrees in civil engineering from the South Dakota School of Mines and Technology; he is also an EOBC and EOAC graduate.

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CLEAR THE WAY

by MG Richard S. Kem
Outgoing Commandant, U.S. Army Engineer School

We've covered a lot of ground...

In preparing to leave the U.S. Army Engineer Center and School for my assignment as DCSENGR in USAEUR, I reviewed the goals I set in 1984. My first "Clear the Way" defined our task: "to ensure the effectiveness of combat engineers as members of the combined arms team on the AirLand Battlefield." I'm glad to say that we've steadily progressed toward that goal.

With a focus on warfighting effectiveness, several major actions have evolved. These include E-Force, equipment modernization, the Engineer Command and Control System, and participation in the Army Family of Vehicles.

E-Force embodies our major initiative: restructuring engineer forces to meet the challenge of AirLand Battle. To date, we have redesigned engineer forces in the light divisions and corps and at echelons above corps. Current efforts focus on getting concept approval of E-Force in close combat heavy forces, thus bringing essential engineer support to maneuver commanders.

The "challenging and realistic" engineer training I hoped to see is here. The National Training Center and our growing experience in Latin America have strengthened our active and reserve forces. Training at NTC and in SOUTHCOM have demonstrated our valuable contribution to the Army's warfighting capability.

The Brigade Engineer has been recognized and accepted as a key staff member. Engineer participation on all staffs in TAC, Main, and Rear command posts is now sought to improve maneuver on the dirty, lethal AirLand Battlefield.

During the past few years, we have increased the emphasis we place on leadership training for our officers. We are confident that EOBC and EOAC graduates who become task force engineers are fully capable of offering support essential to the maneuver commander.

Improved training and E-Force can work only if our soldiers are properly equipped. I have seen the M9 Armored Combat Excavator (ACE) through testing and into production. New commercial construction equipment and small emplacement excavators (SEE) are also about to enter service. Mechanization of Corps Engineer Battalions in Europe is nearing completion. VOLCANO and TEXS development are proceeding.

To ensure engineer responsiveness in AirLand Battle, we have designed the Engineer Command and Control System to become a vital part of the Army's tactical command and control architecture. We have been part of the Army's future look in developing Engineer variants for the Army Family of Vehicles.

Further enhancing the cohesiveness of the Army engineers, we have become part of the Engineer Regimental System, thus strengthening bonds of loyalty and commitment among engineers, and emphasizing the kinship between Active and Reserve Components.

My service as Engineer Proponent has been a great challenge. Like any job that never becomes boring, it is also a job that is never done. I leave the Engineer School and Center knowing that General Reno inherits the potential for a stronger engineer force—and has a long road to travel with you to Fort Leonard Wood and on your missions around the world.

In the past 3 years, we have captured some high ground. But this represents only our intermediate objective. Give General Reno your support, and together we will continue to strengthen our warfighting capability.

CLEAR THE WAY

by MG William Henry Reno
Incoming Commandant, U.S. Army Engineer School

There's a challenging road ahead...

As I assume command of the Engineer Center and School, I eagerly anticipate traveling with you the "long road" General Kem speaks of in his parting remarks. Our road map for the future outlines an exciting journey—it will be up to us to advance toward planned milestones, and open new territory when opportunities arise. Let's look at the landmarks before us:

E-Force implementation: Our immediate goal is to field E-Force. We will work to get early concept approval for the implementation of E-Force in close combat heavy organizations. When it is fully fielded, E-Force will enable us to bring maneuver commanders optimal, flexible battle support.

Expanded training opportunities: We're going to expand the training successes of the NTC in coming years. The Combat Maneuver Training Center at Hohenfels, West Germany, will offer engineers in the European Theater the opportunity to carry out NTC-style maneuvers. The Joint Readiness Training Center at Fort Chaffee affords a realistic training arena where light engineers can execute combined arms maneuvers in low intensity conflict situations.

To extract the maximum benefit from combined arms training, we must work hard for realism, scrutinize our performance, improve what's good, and fix what's broken.

Publications: Current doctrine must support the continuing evolution of the engineer force. You should soon be carrying the new FM 5-34, *Engineer Field Data*, and the coordinating draft of FM 5-116, *Engineer Operations (Echelons Above Corps)*, completed under General Kem's proponency. We plan to revise FM 5-100, *Engineer Combat Operations*, and to field FMs 5-71-100, *Engineer Operations in Support of Close Combat Heavy Forces*, and 5-71-101, *Engineer Operations in Support of Close Combat Light Forces*, in the near future. These manuals will incorporate the lessons we are learning at NTC and in Latin America, bringing engineers to the threshold of a quantum leap forward in combat effectiveness.

New equipment systems: Capable engineer support depends on powerful, effective engineer equipment. Several systems are on deck—I want to see them implemented soon. These include the M9 armored combat earthmover (ACE), the small emplacement excavator (SEE), the VOLCANO scatterable mine emplacement system, the tactical explosive system (TEXS) for rapid antitank ditching, and the counter obstacle vehicle (COV). To enhance training, we aim to field improved mine effects simulators and to open the Battle Command Training Center (BCTC) at Fort Leonard Wood.

Transition to Fort Leonard Wood: We also look down the road toward a geographical landmark—a new regimental home for the engineers. We envision greatly improved engineer training on a site that brings all engineer training together, gives us ample maneuvering room, and offers state-of-the-art facilities.

As I lead you in executing this complex and long-awaited move, keep this in mind: Our destination is not just a new place. Our goal is to move ever closer to combat readiness—perfecting our training, reorganizing the force, fielding new equipment. If we do that, we'll reach our real destination: **Engineers as a fine-tuned combat arm.** *Essayons.*

BRIDGE THE GAP

by CSM Matthew Lee, Jr., U.S. Army Engineer School

Accomplishments come to units that meet high expectations every day, doing it right the first time every time...

Expectations. That word is a mouthful, one we sometimes find is pretty hard to swallow. A major lesson of modern times is that we shouldn't let ourselves be put in a box by expectations. The Army has found out that Americans of all races and origins and of both sexes can work together as good soldiers. That upset a lot of expectations. We hear a lot about stress and learning to get your expectations in line with what you can really do. Stressed-out leaders and followers can destroy themselves and a mission in a hurry.

But expectations have a positive side. This issue of ENGINEER offers evidence that high achievement goes to engineers who have high expectations. The success stories on these pages aren't just about units that experienced the drama of a wartime deployment, or even about units participating in high-intensity training on maneuvers. Accomplishments also come to units that meet high expectations every day, doing it right the first time, every time.

We, the engineers, cannot afford to wait for war to get real training or even to wait for the next field exercise. Training time for us is NOW—in the chow line, in formation, in the barracks. Hip-pocket training must be the tool that we use. We must continue to study and wait; the critical test is sure to come.

Here's what the Army expects of Engineers: We're the people who know how to build whatever needs to be built, and to do it right. We're the people who can cross the gap in the road, knock down the obstacle in the way. When we build, we must build to standard: We're expected to be reliable. Commanders expect our makeshift solutions to be the best available. We must not fail them.

We often meet those expectations as small units where NCO leadership is critical. Look at "*Army Well Drillers in the Rapid Deployment Force,*" p. 23, and "*Engineer Cellular Teams,*" p. 30. These units perform highly specialized tasks. Their NCOs have to be self-reliant experts, able to go ahead and do the job—anywhere, any time, under any conditions. The soldiers in these units must be well trained.

Training works only if it is done by NCOs who set high standards and lead by example (see "*Discipline and Unit Performance,*" p. 44). Training pays off only if you expect to get the most out of every event. "*Repairing Historic Gold Camp Road,*" p. 27, and "*Building a Water Line on Tiger Island,*" p. 19, are good examples of sustainment engineering projects that let units find out if they are what they're expected to be—and how to cope with the unexpected.

And a word to all of you who know we can't always do the job "by the book"—When you can, DO. Strengthen your unit's ability by practicing at peak standards when you have enough time and the right resources. If your soldiers have the habit of producing excellent work (see "*The Three-Phase Inspection System,*" p. 33), they won't be satisfied to do less than their best—even in tough conditions.

Read "*Royal Engineers' Postwar Cleanup in the Falklands,*" p. 13. The author of that article expected his NCOs to rebuild a wind-devastated airfield runway on their own. He wasn't disappointed. That's the engineer tradition in the U.S. Army too. We know our jobs. We're ready for the unexpected. We don't disappoint the units we support—we meet their expectations. It's the engineer way.

Engineer Update

— School News —

Noncommissioned Officer Academy (NCOA)

Academy Opens The Fort Belvoir Noncommissioned Officer Academy began operation 1 April, 1987, in order to comply with recent TRADOC guidelines which specify that all NCO training must be conducted in an NCO academy. Previously, advanced NCO training on Fort Belvoir was conducted by the Directorate of Military Engineering, and the administrative aspects were coordinated by the NCO student detachment, according to CSM Frank Gibert, NCO Academy commandant.

Before coming under the auspices of the academy, the POIs focused primarily on the technical aspects of the NCOs' function. "Our intention," said CSM Gibert, "is to emphasize leadership and warfighting in a combat environment."

The academy's history will be a brief one, however, as plans are already under way to move the courses taught at the school to Fort Leonard Wood, Missouri. Currently, only BNCOCs are held at Fort Wood's NCO Academy. The move is scheduled to begin in April, 1988.

Directorate of Combat Developments (DCD)

Idea Program Announced Have you ever found a problem with a fielded engineer system and thought you had a good solution? Have you ever had a suggestion for a change in organization or training that would make your job easier? Have you ever had a good engineer-related idea, but you did not know how or where to get it adopted? DCD has initiated actions for a new program to help your ideas get tested and adopted. It will be called ESSAYONS.

ESSAYONS will provide a fast, low-cost, and informal means for the Engineer School to evaluate your ideas and adopt them if they work. ESSAYONS is not intended to take the place of the Army Suggestion Program, because the Army Suggestion Program will evaluate your idea but may not test and adopt it. ESSAYONS will give your ideas the proper attention from the Engineer perspective, and, if necessary, test your ideas in an operational environment. It is a quick method to improve your equipment, organization, or training.

Anyone may provide an engineer-related idea. Just clearly describe your proposal in writing (if necessary, provide sketch) and send it to—

Commander
U.S. Army Engineer School
ATTN: ATZA—CTD (ESSAYONS)
Fort Belvoir, VA 22060-5281

Be sure to include your name, address, and AUTOVON number for us to contact you in case we have questions regarding your ideas.

Department of Military Engineering (DME)

Training Developments DME is developing field circulars for engineer operation at echelons above corps and for airbase damage repair. Both will be fielded in late fall 1987.

The DME is also developing the ARTEP Mission Training Plan for the engineer battalion (combat) (heavy). The coordinating draft should be fielded in the winter of 1987 for field comment.

Beginning in FY 88, DME will offer weekend courses in horizontal construction, theater of operations (TO) structures, TO utilities, and construction management. Each will be offered twice per year. Check the school course catalog for exact dates.

Directorate of Military Logistics (DML)

Mast Systems Group Course The 52D10 Branch of DML recently began teaching the direct support/general support Hydraulic-pneumatic Mast Groups Repairer (C-9) Course. During the 18-day course, students are trained in the operation of the mast groups systems, DS/GS maintenance procedures, DS/GS troubleshooting of mast groups and related test equipment, and the use of specialized tools.

The course is open to Active Army and Reserve Component Specialists 4, corporals, and sergeants assigned or on orders to a duty position that requires the awarding of ASI C-9. Active Army personnel must have at least 10 months of active duty service time remaining after completing the course. For more information about the course or enrollment requirements, contact SFC Tucker, DML Operations Branch, AV 354-2314/1036.

Engineer Update

Directorate of Evaluation and Standardization (DOES)

Lessons Learned Bulletin The *Lessons Learned Bulletin* summarizes experience gained from worldwide training exercises. An updated bulletin is published each quarter and distributed to active, reserve, and National Guard engineer units (company level and above), DEHs, districts, and major commands.

To assist the Engineer School in collecting relevant lessons learned, field units need to provide after-action reports (AAR) from their training exercises and information concerning doctrine, equipment, and material. Information and AAR's should be sent to: Commandant, U.S. Army Engineer School, ATTN: ATZA-ES, Fort Belvoir, VA 22060-5271.

If your unit is not receiving *The Lessons Learned Bulletin*, contact SFC Kovak at (703) 664-4172 or AV 354-4172.

Engineer Orientation Team (EOT) EOT is currently scheduling visits for FY 88. If you would like to see the EOT presentation or have them schedule a visit with your activity or active duty or reserve component, contact: Commandant, U.S Army Engineer School, ATTN: ATZA-ES (SFC Rexrode), Fort Belvoir, VA 22060-5271 or call (703) 664-4172/1124 or AV 354-4172/1124.

Department of Combined Arms School (DCA)

Engineer Histories Available on Video The Department of Combined Arms, the U.S. Army Engineer School, and the Historical Division, OCE, have jointly sponsored a series of oral histories now available on video tape. Titles include "Engineers in the Battle of the Bulge" and "Engineers in the New Guinea Campaign 1942-1944."

Three more presentations soon will be available, including histories of engineers in the mountains of Italy and in the initial Rhine River crossings during World War II and engineers in the Korean War.

Video tapes of these oral histories are available for loan. Write to ATZA-TA-C, ATTN: Management Branch, U.S. Army Engineer School, Fort Belvoir, VA 22060-5341 or call AV 354-3993.

Engineer School Secretary (ESS)

Publication Cutback The Engineer School, like all TRADOC schools, faces current and projected funding contraints for printing and distribution of student materials. The current mandate is to reduce the number of copies by 15 percent from last year. This policy requires students to turn in texts after completing a course and restricts our ability to satisfy individual field requests for locally printed material and DA publications. We regret the inconvenience.

Directorate of Training and Doctrine (DOTD)

Individual Training Plans Revised A major priority within DOTD this fiscal year is to revise all individual training plans (ITP) for engineer occupations. ITPs lay out strategies and methods used in training. During the first two quarters of FY 87, the Engineer School completed revision of 15 ITPs. Eighteen will be revised during the third and fourth quarters.

General Engineering Manual in Distribution Units should have received FM 5-104, *General Engineering*, through distribution. FM 5-104 provides a doctrinal basis for planning and executing general engineering in the theater of operations. It is primarily concerned with support to noncommitted forces within the Corps and communication zone areas.

Lineman's and Cableman's Handbook Available *The Lineman's and Cableman's Handbook*, which replaced TM 5-765, *Electric Power Transmission and Distribution*, for all personnel holding the 52G MOS, is still available.

To order the book for your unit, send the property book officer's name, Department of Defense activity codes, and document number to: Commandant, U.S. Army Engineer School, ATTN: ATZA-TD-P-CR, Stop 291D, Fort Belvoir, VA 22060-5291.

After initial distribution, units must purchase copies from the publisher, McGraw Hill Book Company, New York.

— Regimental News —

Corps Distinguished Members

On 10 February 1987, letters were forwarded to engineer commanders soliciting nominations for Distinguished Members of the Corps. Nominations received before the 30 March deadline were reviewed by the Regimental Advisory Committee and forwarded to the Chief of Engineers for approval. Since there had not been adequate time for most units to complete their nominations, he decided to await more nominations before further consideration. He did, however, approve the committee's recommendation to designate all living, former Chiefs of Engineers and Corps of Engineers Command Sergeant Majors as Distinguished Members. Honored at Fort Belvoir's annual Engineer Dinner on 8 May were—

LTG Joseph K. Bratton (Ret)
LTG William F. Cassidy (Ret)
LTG Emerson E. Itschner (Ret)
LTG John W. Morris (Ret)
CSM William Leach (Ret)

LTG Fred J. Clarke (Ret), the Corps' Honorary Colonel (also a former Chief), participated with the current Chief, LTG Elvin R. Heiberg, in the designation presentation ceremonies.

These new Distinguished Members join General Bruce C. Clarke (Ret), who was named the Corps' first Distinguished Member earlier this year.

Concerning selection criteria for Distinguished Members, the committee determined that active officers and enlisted should not be eligible for nomination by their respective units. It further determined that any individual serving in a chain-of-command position above a nominating unit, or a currently serving Chief of Engineers or Corps Command Sergeant Major, should not be eligible until reassignment or retirement.

With the nomination procedure firmly in place, units may again begin consideration of Distinguished Members. Each unit may nominate one officer and/or enlisted each year. Later this year, letters will be forwarded to all engineer commanders, soliciting nominations in preparation for the 1988 Engineer Dinner, where new selectees will be recognized.

Commanders having difficulty tracing unit histories may arrange for unit representatives to visit the History Office of the Office of the Chief of Engineers to conduct research. Units needing this assistance should contact Mr. Charles Hendericks, Staff Historian, at (202) 355-3564. Questions regarding the overall selection process may be directed to CPT Jeff Korcan, Corps Adjutant, at the Engineer School's Personnel Proponency Office, (703) 664-2287/3760 (AV: 354-2287/3760).

— Career Notes —

Commissioned Officers Branch

Captain's Promotion Board to Meet MILPERCEN will convene a Captain's Promotion and Conditional Voluntary Indefinite (CVI) board on or about 9 September, 1987. Zones of consideration for promotion to captain consist of all 1st lieutenants with the following dates of rank:

Above the zone: 860331 and earlier
Promotion zone: 860401 thru 861121

All eligible officers should review their Official Military Personnel Record (OMPF) and their Officer Record Brief (ORB) prior to the convening of the board. Administrative and procedural questions may be directed to the Officers' Promotion Section, MILPERCEN, DAPC-MSP-O, 200 Stovall Street, Alexandria, VA 22332-0400, AV 221-9340.

Other than Regular Army (OTRA) officers in the "first time considered" zone for promotion to captain, who desire to remain on active duty past their obligated voluntary (OBV) date, must apply for CVI status for consideration by the September CVI board. Officers cannot apply for CVI after they have been selected for captain. Officers who choose not to apply for CVI when they are in the "first time considered" zone for captain will not be permitted to apply at a later date. Applications should be submitted in original and one copy through the chain-of-command, IAW AR 135-215, to arrive NLT 3 Aug 87 at the Combat Support Arms Career Management Division, MILPERCEN, Attn: DAPC-OPE-P, 200 Stovall Street, Alexandria, VA 22332-0400, AV 221-7815.

Engineer Update

NCO and Enlisted Soldiers Branch

Appealing Your Enlisted Evaluation Report Officials at HQ Department of the Army believe that NCOs are not using the Army's Appeal System when they believe they were rated inaccurately or unfairly. Last year only 336 appeals reached the Army Deputy Chief of Staff for Personnel Enlisted Special Review Board (ESRB), which is the Army's primary authority for ruling on appeals based on claims of inaccurate or unjust evaluation. There are more than 277,000 active duty NCOs. Only five Reserve Component NCO appeals reached the board.

Appealing is not an act of futility. In 1986 full or partial relief was granted on 38 percent of all appeal cases completed. The guidelines for appeals are contained in Chapter 4 of AR 623-205, *Enlisted Evaluation Reporting Systems*, to which Appendix G has recently been added to provide more definitive guidance for their construction. The staff judge advocates and your personnel services center can also help you.

For additional information concerning appeals, contact the agency listed below which is responsible for your component:

Active Duty NCOs	Commander U.S. Army Enlisted Records and Evaluation Center ATTN: PCRE-RE-A Fort Benjamin Harrison, IN 46249-5301
Reserve NCOs	U.S. Army Reserve Personnel Center ATTN: DARP-PRE-A 9700 Page Boulevard St. Louis, MO 63132-5200
National Guard NCOs	Chief, National Guard Bureau ATTN: NGB-ARP-E Washington, D.C. 20310-2500

— News & Notes —

New Mine-Clearing Developments On 6 April 1987, the Belvoir Research and Development and Engineering (RD&E) Center awarded a $2,185,000 production contract for the Army's new Cleared Lane Marking System (CLAMS) to BMY Corporation of York, Pennsylvania.

CLAMS will be used to help vehicle drivers follow safe paths cleared through minefields. Mounted on the rear of the lead minefield-breaching vehicle, it dispenses colored flags that can be seen easily during the day. Lightsticks are provided for night operations.

A device attached to the vehicle's odometer controls the dispenser, dropping the markers at constant intervals. Units are scheduled for delivery between November 1987 and February 1988.

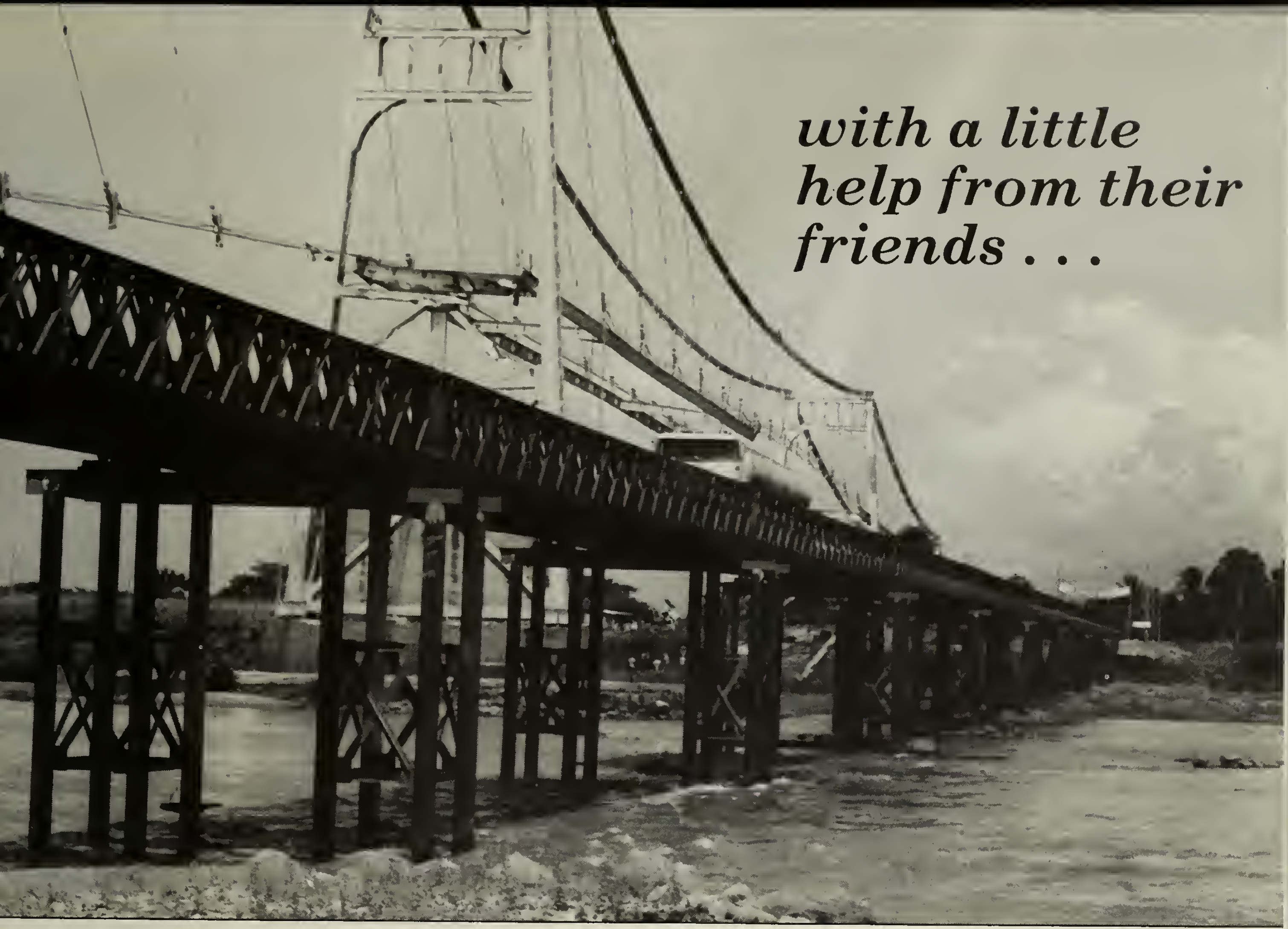
The Belvoir RD&E Center also has evaluated foreign "flail" technology to determine its effectiveness and suitability for clearing safe paths through minefields.

A vehicle designed by Aardvark Mine Ltd, of Aberdeenshire, Scotland, was tested by the U.S. Army Armor and Engineer Board at Fort Knox, Kentucky, to obtain data that could eventually result in a tank-width vehicle mine clearing system for combat engineers.

After reviewing reports of past designs, Aardvark developed a flail that weighs less, costs less, requires less power, lasts longer, and provides a better beat pattern than its predecessors. The Aardvark uses less power to drive its flails, although it employs more chains per foot of rotor than older designs. The tip weight has been matched with the flailing speed to produce a better pattern of contact with the ground. During trials, one Aardvark flail cleared charges of up to 3.6 kilograms of explosive with virtually no damage.

The design evaluated by the center weighs 13½ tons—10 tons for a prime mover and 3½ tons for the flail unit. Mounted on a custom-built, half-track vehicle, the flail unit is a 10-foot-wide rotor with 72 to 79 chains having disc-shaped striker tips. Other features include automatic contouring and depth control, retractable sidearms for air transport, an armored cab, and an optional rotor with 60 heavy chains for use against buried antitank mines.

Data from these tests will be used to design a flail system providing a path as wide as the vehicle selected to perform as its prime mover.



with a little help from their friends . . .

Salvadorans Rebuild Two Bridges

by Joseph T. Cowgill

El Salvador's people have been at war for 8 years, struggling with a guerrilla insurgency that has alternately raged and smoldered. Lives and homes have been destroyed, and the population of this tiny but strategically located country systematically terrorized.

Like many Central American nations, El Salvador has largely undeveloped rural areas and a fragile transportation network. Guerrilla forces have focused many of their destructive efforts on the nation's precious infrastructure, making movement and communication difficult wherever they can. This is the story of one guerrilla attempt to disrupt travel in El Salvador and how U.S. Army Engineers helped to make sure the effort failed.

Rio Lempa crossings destroyed

The Rio Lempa runs through country hotly contested in El Salvador's civil war. Flowing south along the Honduran border, the river crosses the country on its way to the Pacific, severing the eastern third of El Salvador from the west. Two bridges over the river—Puente San Marcos and Puente Cuscatlan—are the sole links between eastern and western El Salvador.

The Salvadoran Army, realizing the importance of these bridges, had manned them with light security forces. But the small guard contingents were easily circumvented by the rebels. In late 1982, they managed to plant demolitions and blow up both spans, making the Rio Lempa a major barrier.

The guerrillas' sabotage, continued ambushes, and harassment failed to halt transportation altogether, but caused significant problems on the routes served by the bridges. To provide a roadway of sorts, the government routed traffic across a hydroelectric power plant dam near Cuscatlan, and converted a railroad bridge to make a roadway at San Marcos. Both these crossings—one of them on the Pan American Highway—were restricted to alternating one-way traffic.

El Salvador seeks Bailey bridges

For more than three years after the destruction of the bridges, the Salvadoran government tried to construct other crossings on the Rio Lempa. These efforts were hampered because the Salvadoran Army had

Salvadoran workers prepare a Bailey bridge span at Cuscatlan.

converted its engineer units to infantry—combating the guerrillas was a top priority. This left reconstruction in the hands of a relatively inexperienced civil works ministry.

Weather and river conditions also thwarted reconstruction work. Attempts were made to push earthen causeways into the river, reducing its normal 600- to 1,000-foot widths to distances that could be easily bridged. But heavy rains and rushing water soon destroyed these structures.

The most feasible solution, the government finally concluded, would be to span the river with Bailey bridges on piers. Through coordination with U.S. agencies, El Salvador obtained some used Bailey bridge sets from the United States. To make the sets serviceable, civilian workers removed paint and rust, primed, painted, and lubricated major parts.

The refurbished bridge equipment was then moved to the two sites by truck—a 2-hour drive from San Salvador on hostile roads.

Army engineers prepare the sites

Mobile District, U.S. Army Corps of Engineers, were called upon in early 1986 to supervise the design, fabrication, and construction of steel pile piers at both sites. This phase of the project took several months—all materials were imported, and heavy equipment, cranes, pile drivers, had to be procured.

Pile driving began in April, but seasonal rains impeded site preparation. High waters and swift currents repeatedly washed away the causeways that were needed for pile emplacement. Because of river bed conditions at Cuscatlan, the last set of piles couldn't be driven in the planned location. Subsurface problems also forced a change in the location of far bank abutments. As a result, the Cuscatlan Bridge's planned length nearly doubled, reinforcing chords had to be used on the far bank span, and the final length of the bridge—usually determined in the design stage—remained unresolved almost to the day the first bridge hit the far bank.

USAES assists in designing bridges

Through USAID, El Salvador requested assistance in constructing the Bailey bridges, and acquired the services of a technical assistant from Bridging Branch, the U.S. Army Engineer School.

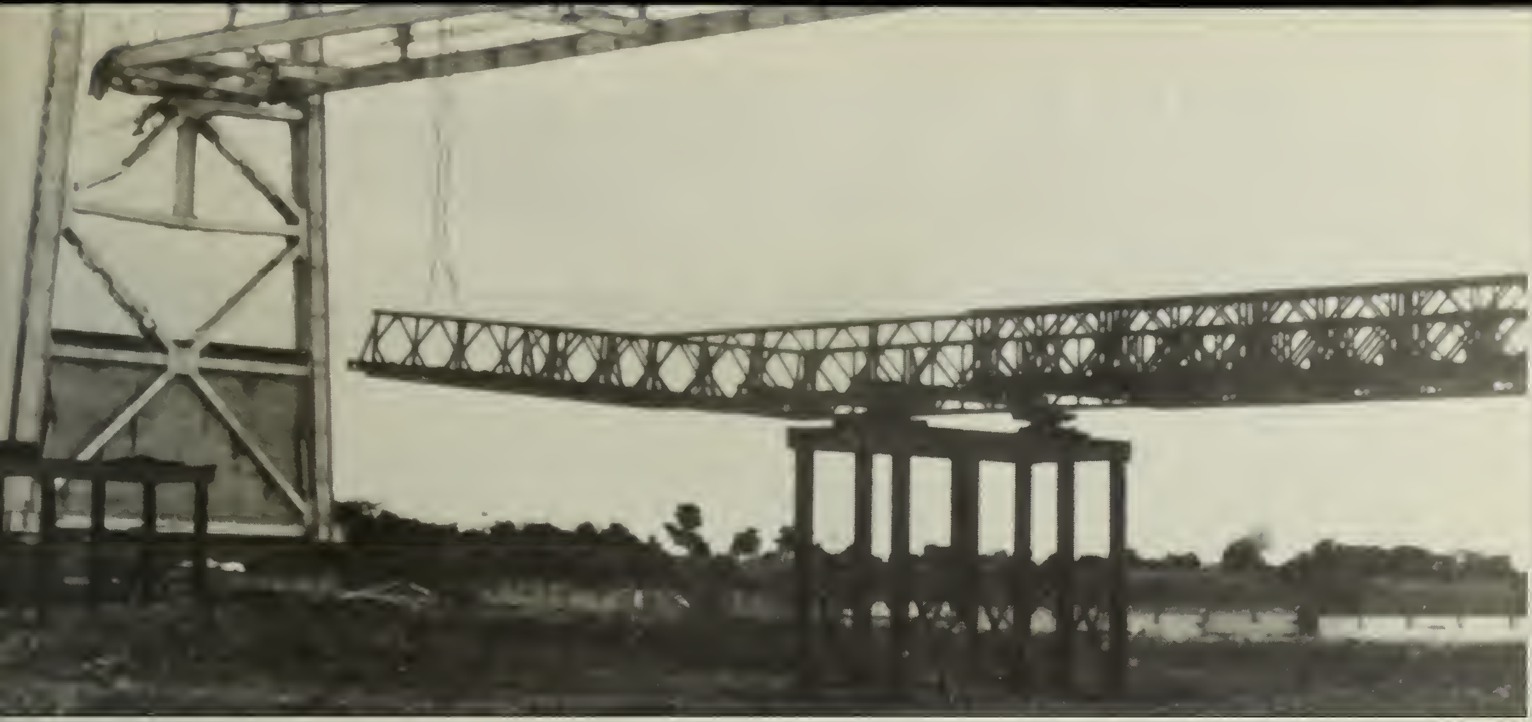
In a 3-day site visit, the advisor determined correct quantities of components, equipment, and manpower, and set up the building sequence. On this occasion and throughout the project, the advisor communicated with his Spanish-speaking counterparts by drawing diagrams and using the universal language of mathematics. Thus, he literally sketched the building sequence for the bridges and drew pictures to recommend solutions to construction problems.

Salvadorans construct San Marcos Bridge

Assisted by the Engineer School advisor, 100 Salvadorans set to work on the San Marcos Bridge. The workers were farmers, construction laborers, steel workers—and one man with Bailey bridge construction experience. On the first 10-hour day only the roller layout, launching nose, and 10 feet of bridge were completed. Training—and the vivid urgings of the host country supervisor—swiftly improved productivity, and 10-hour days soon ended with 100 to 120 feet of bridge constructed and launched.

Construction problems were numerous. Inexperienced Salvadoran workers left leveling bolts out of pile piers 3 and 4. Engineers substituted an epoxy filler, allowing it to cure for a day before extending the launching nose to pier 3.

Crews had to be diverted from bridge construction: one to clean and lubricate parts that arrived on site covered with paint, another to correct problems caused by wrong-sized locally made chess. Gaps between pieces of chess were hammered into the button stringers, and bent pin lugs were repaired.



The damaged Cuscatlan bridge looms above a Bailey span in mid-launch.

Bridge equipment arrived slowly, since most available trucks had to be used to haul rock and fill for the causeway.

Construction speeded up when a cherry picker became available—3, 4, or 5 bridge panels could then be assembled and lifted into place in one move. The cherry picker also eased movement of transoms, stringers, and other heavy components from distant stockpiles to the bridge.

By the end of July, 600 feet of triple-single bridge had been built and 500 feet launched. Bridge-building then halted until the last pier could be finished. Further construction and launching required a dozer pulling the bridge, which could not be done during pier construction.

The final touches on the San Marcos Bridge cost extra effort. During launching across the last four piers, the bridge repeatedly went off the centerline. This was a coordination problem—keeping a pulling and a pushing dozer working together proved tricky.

The final length of the bridge was determined only after both ends were situated over the banks. Errors in the original design and siting put the abutments too far apart. An extra 10 feet of bridge was added to each end span, and chord reinforced. The San Marcos Bridge carried traffic across its 1,140-foot length on 26 August 1986.

Experience speeds construction at Cuscatlan Bridge

The Salvadoran supervisor began the bridge at Cuscatlan in the absence of the USAES advisor. Traveling between sites, he completed and nearly launched one of the bridges at Cuscatlan, while he directed construction at San Marcos.

The supervisor's independent work at Cuscatlan proved to be a mixed blessing. His experience helped him to train his work force at Cuscatlan, putting construction ahead of schedule. But, lacking technical advice, he built and launched the bridge across single rocking rollers rather than using tandem rollers. This created a problem—the bridge was split over the piers. To solve the difficulty, the Salvadoran supervisor and the USAES technical advisor decided to use timbers and plain rollers to replace the missing rocking rollers.

The Cuscatlan Bridge proved harder to launch than the San Marcos Bridge. A comparison of their configurations explains why. San Marcos was over 1,140 feet of triple-single bridge, all spans equal until after final launch. At Cuscatlan, each bridge was over 990 feet long. The launching nose was followed by 190-foot triple-double, chord reinforced, followed by 8 spans of 100-foot triple-single. Launching these bridges was like trying to push a bowling ball with a rope. However, earlier struggles with pulling and pushing dozers had taught workers how to avoid problems.

The complex endeavor at Cuscatlan was made more difficult by guerrilla activity. The guerrillas threatened a 7-day road shutdown on the Pan American Highway, but Salvadoran Army forces provided security for commercial trucks after the second day of the attempted blockade. In the end, guerrillas only succeeded in causing temporary shortages of components.

Construction at Cuscatlan showed how a few months' practice could make cooperative nation building pay off. Salvadoran workers had learned how to work with Bailey bridge under their own supervisor. U.S. engineer expertise stood by to iron out problems. In September 1986, the Salvadorans celebrated—three bridges were opened to traffic, and east-west travel across the Rio Lempa was restored. The Salvadorans, with U.S. cooperation, had thwarted a guerrilla campaign.

Mr. Cowgill was the USAES advisor to El Salvador for the San Marcos and Cuscatlan bridge projects. He is a training specialist, Bridging Branch, Combat Operations Division, in the Directorate of Military Engineering, USAES. He has spent 21 years in active service, mostly with various Army float and panel bridge companies.

AVLB assault ford on the Han River

by CPT John Rivenburgh

Cross the water where *you* choose, and make the battle yours. Here's how the Orange Force (2d Infantry Division) used a surprise crossing to defeat the Blue Force in 1982's joint ROK-US Exercise, TEAM SPIRIT. Convinced that a flank attack on Blue Force would turn the tide, Orange Force maneuver commander, division engineer, and assistant division engineer planned to cross the South Han River and drive west.

They decided to move a mechanized brigade across a major water obstacle. No fords or fixed bridges were available. The few prepared, deep-water crossing points had been used by the enemy. To surprise the enemy, AVLB assets of the divisional float bridge company (6 launchers with 8 bridges) would construct a hasty AVLB overlapping assault ford at an unexpected site.

Emplacing the assault ford

Two days before the attack, E Company, 2d Engineer Battalion, used SCUBA teams, 3-man reconnaissance boats, and shoreline observation to determine the feasibility of the assault ford. The findings were less than ideal (sandy-silty-rocky bottom; 5.5-foot depth, and 5-foot-per-second current), but the river bottom was flat. The battalion commander consulted with the assistant division commander and gave the order to initiate.

To prepare for the mission, the end curbs were removed from the AVLBs and safety poles were fabricated. The first launcher drove into the river and launched its bridge at maximum fording depth. Before the bridge completely submerged, the AVLB commander placed 8-foot safety poles in the river bottom along the sides of the bridge. After the first launcher retreated, a second came forward, launched its bridge, and formed an interlock by overlapping the first bridge 3 feet. In this way, 5 AVLBs spanned 300 feet.

The attack

The third morning, the battalion bombarded the far shore. Under cover of smoke, 37 armored vehicles crossed the overlapping assault ford with only one minor mishap. This surprise maneuver allowed Orange Force to defeat Blue Force in detail.

The findings of the river reconnaissance proved to be more than adequate for the mission. The 5 AVLBs were recovered without damage to bridges or launchers.

The hasty AVLB overlapping assault ford is not suitable for all river conditions—it works best when a ford's only limiting factor is depth. A rocky bottom can cause point loading and damage the bridges. Bridges may sink into a clay or silt bottom, lowering their surfaces below the crossing vehicles' fording depth. Bottom suction may render bridges unrecoverable. Extensive shore preparation is needed when banks are steep or high. Bridges must be retrievable from the near shore.

All this means that a thorough reconnaissance must be conducted. The division engineer and maneuver commander must ensure the benefits outweigh the risks. AVLB crews must train on land to perfect the overlapping techniques. Clearly, the use of this assault ford is heavily dependent on METT-T.

But like all specialized tools, the hasty AVLB overlapping assault ford can be the perfect instrument in the right circumstances—it can let the maneuver force commander exploit enemy weakness.

CPT John Rivenburgh is a Senior Team Leader in EOAC Division of the Engineer School. He has also served as Commander, E Company, 2d Engineer Battalion; and Project Engineer, Albuquerque District, COE. CPT Rivenburgh holds a BS in Civil Engineering from Clarkson University, an MS in Civil Engineering from the University of Connecticut, and is a registered professional engineer in Virginia.

Royal Engineers' Postwar Cleanup in the Falklands

by LTC Michael H. H. Brooke, RE

"When the bullets stop, there will be a cry for Engineers to get the situation back on its feet. Move your Squadron by sea to the South Atlantic, and be prepared to fight if necessary. Your tasks are—

- Reopen Stanley Airfield.
- Clear mines/explosives.
- Restore water supply and essential services to Port Stanley.
- Construct company base camps for the infantry guard force."

Mobilizing

Such were the orders I received just 10 days before 3 Field Squadron sailed for the Falkland Islands on June 19, 1982. My first job was to prepare the squadron to meet the challenge.

The Squadron had recently returned from a construction project in Kenya, so we were well organized for deployment. Our tradesmen's skills in electrical work and carpentry were at their best.

We had little knowledge, however, of the Aluminum Mat Grade 2 (AM-2) of which Stanley Airfield's main runway would be rebuilt, and no expertise whatever in constructing Portakabins and Pakaway Buildings (portable prefabricated quarters and storage facilities), or operating rock drills and rock crushers. These gaps in training would have to be closed quickly.

Key personnel needed immediate training, particularly on the unfamiliar commercial equipment that we would be using. I dispatched Squadron Officers, NCOs, and Sappers to all the civilian firms who would supply our equipment. Each was responsible for returning to the squadron with operating knowledge of a system, and the ability to pass it on to the troops who would use it.

Our primary challenge was AM-2 airfield mat training— we could only do this in the United States. The morning after I received our orders, my Troop Staff Sergeants (E7 Platoon Sergeant equivalent) were with me at Heathrow Airport, on their way to the U.S. Marine Corps' Bogue Field, Cherry Point, NC. If the squadron's NCOs could gain proficiency in laying AM-2, I thought we had a good chance of success. After 4 days of intensive training at Bogue Field, the men were ready to train the rest of the squadron.

Meanwhile in the United Kingdom, the squadron began to prepare for the possibility of combat. All ranks reclassified on their personal weapons, and found ways to increase our potential firepower. The .5-inch Browning machine guns were taken out of our Ferret Scout Cars, which wouldn't be going with us to the South Atlantic.

By the time the NCO contingent returned from the United States, preparations were reasonably well in hand. The Quartermaster (QM) had obtained the necessary stores and engineer equipment. The squadron had been augmented with additional technical specialists in construction trades, power generation, and quality control. Squadron personnel were completing their private arrangements for leaving the country.

The Squadron sailed from Southampton on the appointed day, bound for the Falkland Islands 8,000 miles away. The precious 3 weeks of transit time was spent in weapons training, physical training, and familiarization with AM-2.

A complex job

We arrived in Port Stanley on a wintry July 11. Initially, there was no accommodation ashore. This meant commuting daily by small boat, in weather that was potentially ferocious and always unpredictable. Gradually, however, we established a Squadron HQ in the Falkland Islands Defense Force Drill Hall, which had been used by the Argentinians during their occupation of the islands.

The aftermath of conflict was everywhere evident. Ten thousand Argentine prisoners of war, some of them ill or injured, had not yet all been repatriated. We were not able to shelter them, but we managed to provide them food, water, and medical assistance until British hospital ships began to transport them back to the mainland about 10 days later.

Parts of Port Stanley and its environs were infested with land mines and booby traps. Water was scarce, since the town's main pumping station had been hit by artillery fire. Damaged ships staggered in the harbor, their supplies and munitions waiting to be unloaded or scuttled.

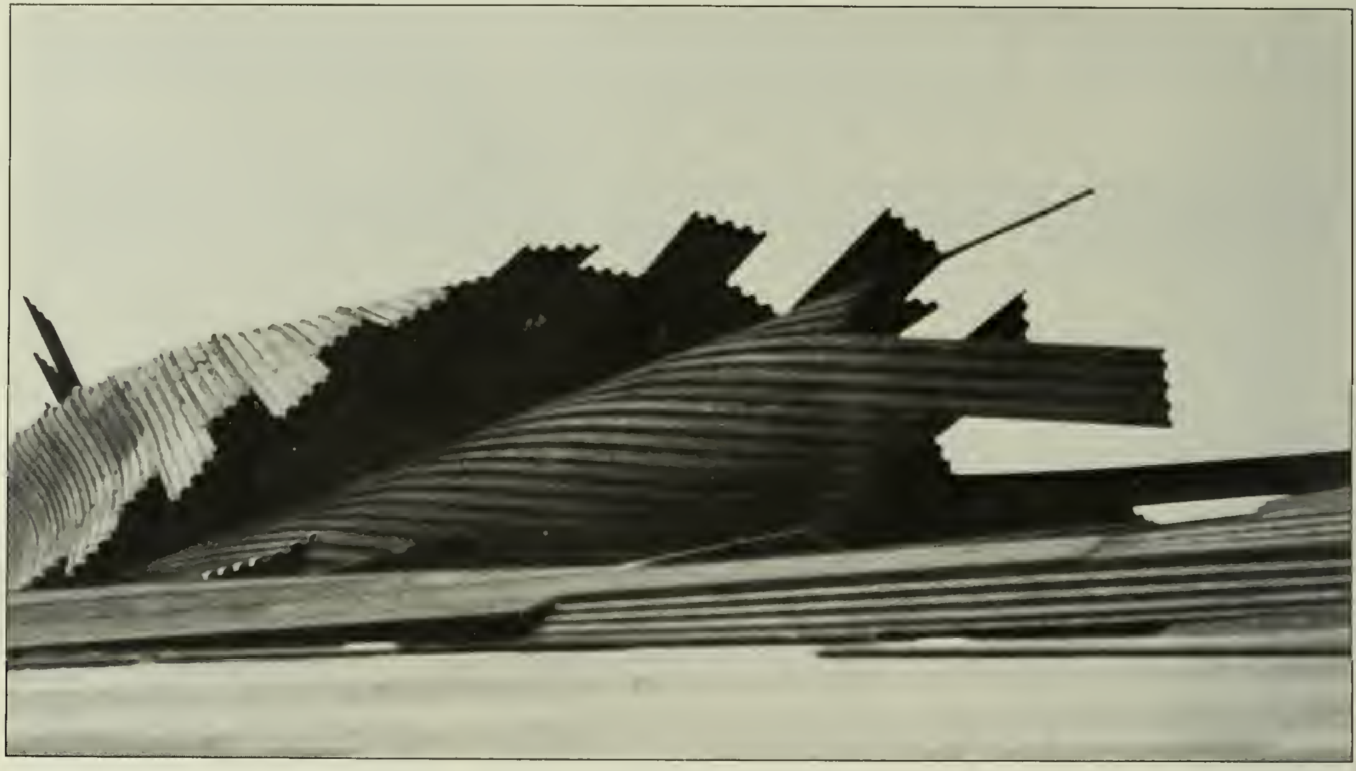
Restoring Port Stanley

Our most urgent task was to restore basic utilities. A military water point was substituted for the damaged main pumping station. Though we had almost no spares for the pumping engines, our Sappers soon managed to bring production to the million-gallon mark.

Meanwhile, the town of Port Stanley was systematically cleared of mines and booby traps. Sappers trained for operations in Northern Ireland conducted the search, dividing the town into small grids and painstakingly combing each square for booby traps and mines.

Rebuilding Stanley Airfield

With 50 Field Squadron, we set about one of our primary objectives—



Hundred mph winds can roll light-weight aluminum airfield mat into a giant tortilla. Panels, visible at edges, are 10 feet by 1 foot and weigh 80 pounds each.

rebuilding Stanley Airfield. Initially, we had expected the airfield to be pitted with deep craters after the Royal Air Force bombing raids by Vulcan bombers. It proved, however, that all but two craters had been illusions. The Argentinians had used large irregularly shaped sheets of vinyl to create a pattern that—from the air—looked like cratering on the runway surfaces. These "craters" were simply moved aside when Argentine aircraft were about to land.

Even though the job to be done proved less heroic than we at first believed, we found it Herculean enough. Grading the airfield surface and filling the craters to strict quality control specifications required full support of quarrying and rock-crushing operations, with which the squadron was not familiar. Clearly, this aspect of engineer support is a critical element in many repair and rehabilitation jobs. I carried away the conviction that cleanup units must be fully prepared to carry out and support quarrying and rock-crushing operations—otherwise the effectiveness of the mission will be impaired.

The goal at Port Stanley was to improve the airfield surface so that it could accept Phantom F-5 fighters, thus releasing the aircraft carrier ***Invincible*** from her standoff station. Because the strip was too short for high-speed fighter aircraft, we also installed runway hydraulic arrestor gear. Day and night, rain and storm, the Sappers labored, and it was a sweet moment to watch the first jet land safely.

But there was little time for celebration. Soon after the commissioned officers had moved on to supervise other construction operations, the light-weight aluminum airfield mat at Port San Carlos, specifically designed for Harrier Operations, was attacked by ferocious 100-mile-an-hour winds and torn away from its moorings. The junior NCOs who had been left in charge of this forward operating base did a superb job of supervising the repairs, which were completed in just 3 days.

Constructing the garrison

When we left 50 Field Squadron to continue expanding the airfield, we turned our attention to camp construction across the islands for the Battalion Guard Force. Our first job was to unload several ships, a task made difficult by lack of suitable lighterage and stevedore experience. However, engineers have always been an adaptable breed, and we managed our job with ingenuity, inventiveness—and cooperation with the port squadron.

Where there had been grassy areas, Portakabins began sprouting from the earth. Each cabin provided accommodation for 10 soldiers. Again, high winds quickly ripped the first cabins from their foundations, but engineers stabilized and provided floor-level insulation for the buildings by stacking sandbags at the ground line and literally tying the Portakabins down with guy wires attached with Spanish windlasses. The same technique was used to secure the portable lavatories.

The camps were constructed by field troops operating more or less independently. The Squadron's junior leadership flexed its muscles unsupervised, providing housing for a garrison guard force of 1½ infantry battalions, 2 artillery batteries, and elements of the RAF. These facilities

Portakabin kits are designed for rapid installation. Here, soldiers steady side panels which drop out of the roof. Assembly can be completed in less than a half hour.

were expected to last for up to 5 years.

An unexpected duty

The Squadron was also called upon to build a permanent cemetery for those of our dead whose relatives had decided they should rest where they fell in action. These 14, including LTC H. Jones, VC, OBE, who had gallantly commanded 2 Battalion, the Parachute Regiment at Goose Green, had been temporarily buried at Ajax Bay. Sappers from 3 Squadron dug new graves at Blue Beach, where the first British Task Force landings had occurred some 5 months earlier. The Sappers had the honor of acting as bearers when Mr. John Knott, then Secretary of State for Defense, presided over the burial ceremony during his brief visit to the islands.

Lessons learned

Six months after our arrival, we embarked for home knowing that we had met the mission's challenge. In less than 2 weeks, we had prepared ourselves for a number of unfamiliar engineering tasks. We had mobilized, upgraded our combat readiness, and assimilated needed expert personnel. Dispatching our NCOs to sources of expertise for immediate information and training had been critical to our success in carrying out our job after we arrived.

The traditional engineer virtues of flexibility and initiative served us well when we encountered the Falklands' hostile weather conditions and serious resource deficiencies. The trials we met taught us—and should remind all those who must be prepared to mobilize to remote and unfamiliar terrain—that small wars operations will inevitably present a set of difficulties which no unit can anticipate.

As we worked with limited personnel and long supply lines, we abandoned the intensive micromanagement we are so often tempted to practice in peacetime. Our NCOs proved that they could accomplish massive tasks at short warning without constant oversight by officers. In sum, the ingredients key to our success were—

- Keep the unit's administration on the ball. If the admin's right, the job will be right.
- Think clearly; make a simple plan but remain flexible. The situation on the ground will always surprise you.
- Trust your subordinates. Allow troop commanders to use their initiative to get on with the job.
- Train hard, even if time is short. Training pays.

LTC Michael H. H. Brooke, RE, was commissioned in the Royal Marines in January 1967, and served in Singapore and at the Commando Training Center. He transferred to the Royal Engineers in 1972 and has seen service in West Germany, Northern Ireland, Cyprus, Kenya, and the Falkland Islands. LTC Brooke was the British Exchange Officer at Fort Belvoir from l985 to 1987, serving with USAES, Department of Military Engineering, as Chief, Combat Operations Division.

Military Pipeline Operations

by CPT Robert W. Metz

AirLand Battle runs on tracks, rolls on wheels, flies on wings—and feeds on petroleum. How much POL can major conflict eat? In World War II, half the logistical tonnages were petroleum products. Field armies and tactical air forces consumed 3 to 8 hundred thousand gallons of fuel per day.

To feed the need, Army engineers laid over 3 thousand miles of military petroleum pipelines in Europe, along the Mediterranean, and through China-Burma-India.

In Vietnam and Korea, petroleum's share of logistical tonnages rose to over 60 percent. It is likely that POL will become even more vital in the future.

These precious supplies can't be unloaded and picked up in rear areas. Fuel and fuel products must go where the soldier goes—as far forward as the tactical situation dictates.

Engineer, Quartermaster, and Transportation units cooperate to provide bulk petroleum distribution systems. They see that supplies move smoothly from ships to armies by road, rail, air, inland waterway, and above all, by pipeline.

Why pipelines?

Pipelines are relatively time-consuming to build and susceptible to enemy disruption. In Vietnam, the enemy was able to cause losses of over 2.5 million gallons of fuel per month. Slow construction rates may also mean that pipelines lag behind the rate of combat advance, making fuel supply to forward units uncertain.

Despite these disadvantages, pipelines remain the most efficient way to distribute bulk petroleum. They allow a continuous flow of fuel, whatever the weather and terrain. They also keep road and rail networks open for materiel that cannot be moved in any other way.

Who runs the system?

Within the theater of operations, several branches of the Army support petroleum distribution. The Quartermaster Petroleum Group executes the bulk fuel distribution mission. Assigned directly to the Theater Army, the group works with the Theater Army Materiel Management Center and host nation staffs to develop a petroleum distribution plan. This plan is the basis for designing, building, and operating the system, which the petroleum group and its subordinate units then operate and maintain.

Who builds the pipelines?

A combat heavy engineer battalion usually builds the distribution system. The battalion prepares sites and builds bulk storage, pump stations, fuel jetties, and other related pipeline facilities. A pipeline platoon element from a pipeline construction support company often performs part of the construction.

The pipeline construction support companies rarely operate independently. They usually provide technicians and specialized equipment to help engineer battalions with construction, rehabilitation, and repairs. These companies are the inland pipeline experts.

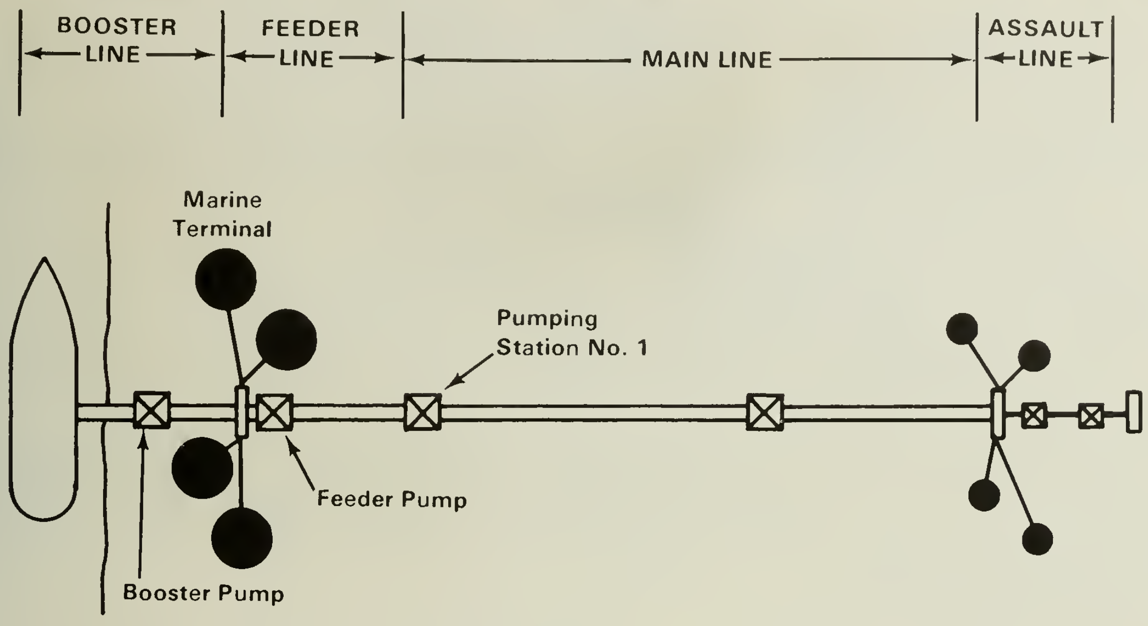
Engineer port construction companies provide expertise for offshore petroleum facilities. These companies can lay offshore assault hose lines and submarine pipelines, and build POL jetties and tanker discharge facilities. Radiographic welding teams and diving teams may be attached to these companies. The teams can test, inspect, and repair pipelines and POL jetties.

How is the system designed?

Theater pipeline systems are designed to be easy to construct, yet meet fuel needs in the theater. The designer must consider the design fuel (the heaviest fuel the line will carry), the mean low temperature in the area, the flow rate needed to meet fuel requirements, and the number and type of pipeline facilities available in the theater.

The engineer officer designs the line in modular form for each of the three types of lines in the system: the booster line, the feeder line, and the main line. Quartermaster Corps handles assault pipelines at the dispensing end of the system.

The booster line transports fuel



	PURPOSE	*RESPONSIBILITY*	*MAIN COMPONENTS*
BOOSTER LINE	Takes fuel from tanker to base terminal tank farm	Engineer Co (PC) ACB Engr Bn (CH)	Submarine pipeline (undeveloped Theater) Docking facility Booster pump station (if required) API steel pipe
FEEDER LINE	Primes 1st main-line pump station	Engr Bn (CH) Pipeline Co	API steel pipe Feeder pump station
MAIN LINE	Majority of pipeline	Engr Bn (CH) with Pipeline Company	Lightweight tubing (LWT) API steel pipe (if required) Main-line pump stations
ASSAULT LINE	Dispenses fuel at receiving end of pipeline	QM	Collapsible hoseline Assault pumps

Schematic design for POL pipeline port facilities

from the offshore tanker to the first or base terminal tank farm. The design of this line depends upon the developmental stage of the theater. In an immature theater, a submarine pipeline may be needed to discharge the fuel, while in a developed theater, a pier facility may be available for direct shoreside discharge. In this line, the design is based upon the flow rate required to unload a tanker, as well as the design fuel and temperature.

A feeder line, usually from ½ to 1 mile long, may be needed to transport fuel to the first main-line pump station. This line's flow rate depends upon the fuel requirements upstream and the operating hours of the feeder pump station. The feeder pump station will provide the priming pressure needed to operate the first main-line pump station.

The longest and the most time consuming line to construct is the main line, which may cover hundreds of miles. The main line has the same flow rate as the feeder line, but is constructed of a lighter weight steel tubing because of the distances it must cross.

The engineer must understand the design parameters of these three lines, as well as all other related storage and supporting facilities addressed in the Army Facilities Components System. With this knowledge, and an understanding of the basics of fluid flow, he can design a pipeline system that supplies fuel throughout the theater.

What's new in military pipelines?

New developments continue to increase the effectiveness of the military pipeline system. The Joint Chiefs of Staff contingency plans require rapid delivery of bulk petroleum in the theater. Construction rates of up to 25 miles of pipeline per day are needed if these requirements are to be met.

To meet the demand for speed, several systems are being developed. The Automated Pipeline Equipment System's truck-mounted hopper feeds pipe into a joiner—it can connect over 1 thousand feet of pipe in minutes. The Army is also moving to a lighter-weight aluminum pipe that will decrease the rate of manual construction by more than half.

For gap crossings, where the threat of leaks is most critical, the Army has developed the Pipeline Outfit Petroleum (POP) System. The POP System can swedge pipe together, creating a tighter bond over the gap.

These systems can reduce construction time and enhance the reliability of future distribution systems, meeting the needs of the highly mobile AirLand Battle.

Military pipeline systems are the key to the bulk petroleum supply. They can effectively distribute fuel to mechanized forces, enabling them to maintain the offensive in AirLand Battle.

Engineer support to petroleum supply is designed to be an effective combination of both general and specialized skills. Engineers make a critical contribution to designing an efficient system that can be constructed swiftly. The all-round capabilities of the combat heavy engineer battalions are combined with the highly developed skills of small, specialized units to build the pipeline. This pairing of resources minimizes duplication of low density skills, yet provides the manpower and equipment needed to perform the mission. The effectiveness of the operation is ensured by intensively training engineer units in both the Active and Reserve components.

Through management, training, and modernization, engineers have ensured that their part in the petroleum pipeline supply mission will be successfully accomplished. Maneuver commanders can be sure they'll get the fuel they need to win the AirLand Battle.

CPT Robert W. Metz is currently an instructor in Structures and Utilities Branch, Department of Military Engineering, U.S. Army Engineer School. He has also served with the 497th Engineer Company (Port Construction) at Fort Eustis, Virginia. CPT Metz is a 1982 USMA graduate and a graduate of EOBC and EOAC. He is completing a Master's degree in engineering administration at George Washington University.

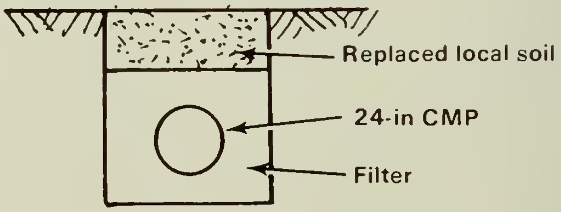
Engineer Problem

You are an assistant S-3 (civil engineer) for a combat heavy battalion. Proper design and construction of a subsurface drain, 2,000 meters long, is essential for the accomplishment of your unit's mission. Available subsurface drainpipe—perforated, 24-inch corrugated metal pipe (CMP) with hole diameters of ⅜ inch—is adequate for your use.

Your materials quality specialist (MQS) obtains the following data from sieve and hydrometer analyses of the soil at the site of the proposed drain:

Size	% Passing	Size	% Passing
⅜ in	100	#80	50
¼ in	98.5	#100	46.5
#4	97	#200	32.5
#10	89	0.04 mm	22
#20	78	0.02 mm	11
#40	67	0.01 mm	3
#50	60		

All of the grains of this soil pass through the pipe perforations, so you know that the drain needs a filter.



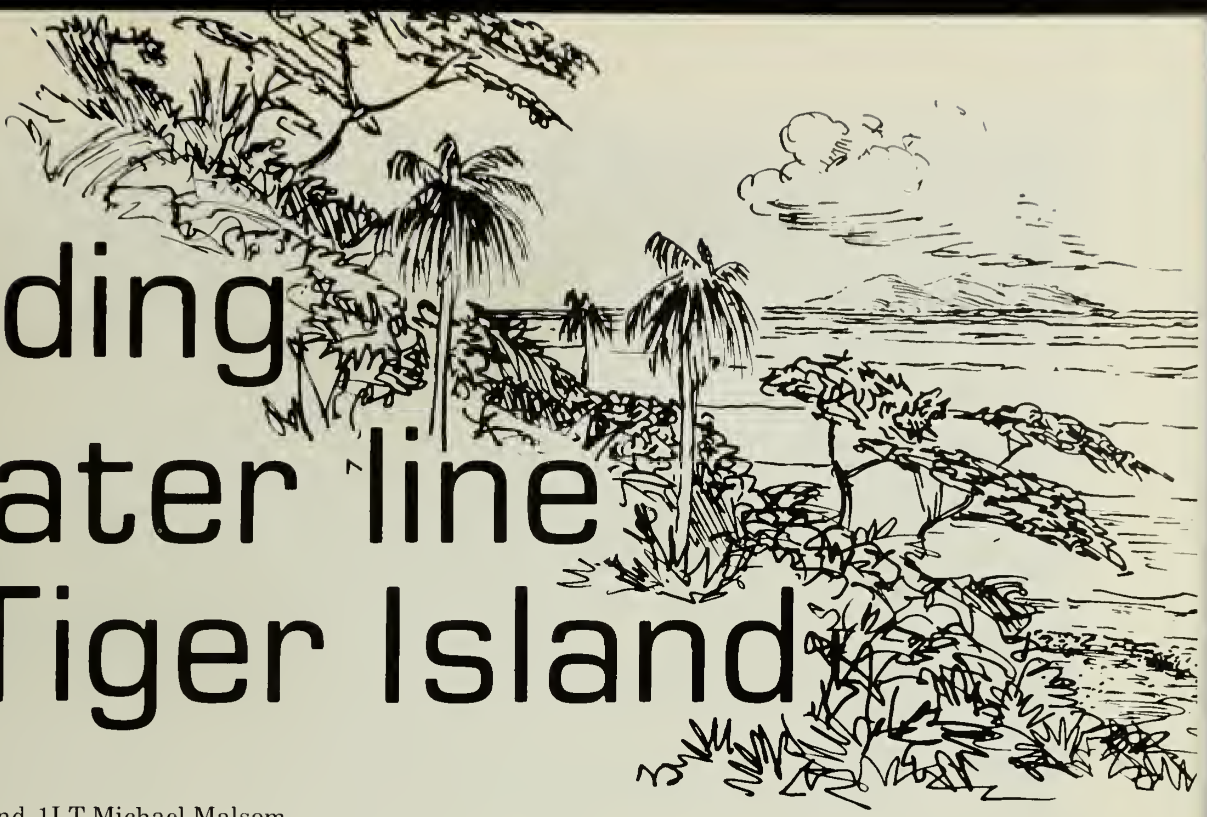
The battalion S-2 locates a more coarse-grained soil at another site. He estimates the quantity of soil to be 1,750 bank cubic yards (BCY). Your MQS analyzes the soil as a possible filter for the drain. He determines—

Size	% Passing	Size	% Passing
1½ in	95	#50	18
¾ in	90	#80	13.5
⅜ in	83.5	#100	12.5
¼ in	77	#200	8
#4	72	0.04 mm	5.5
#10	47.5	0.02 mm	3.5
#20	30	0.01 mm	1.5
#40	22		

Questions to Answer

1. Is the more coarse-grained soil suitable as a filter for the drain?
2. If it is suitable and the S-2's estimate is correct, is there enough filter soil to construct the drain?

Building a water line on Tiger Island



by CPT Jim Balocki and 1LT Michael Malsom

Tiger Island rises 2,500 feet above the Gulf of Fonseca, just off the Pacific coast of Honduras. The steep slopes of the island's extinct volcano are littered with reminders of a fiery past. Amapala, the only settlement, is a shadowy ghost town—though in a past life it was a lively port. On this forgotten island, the soldiers of Bravo Company, 52d Engineer Battalion (Combat Heavy), built a pipeline from a well at the base of Tiger Island to a storage tank at its summit. Our goal—to provide water for personnel stationed there.

Our objective was simple—our task difficult. There was no electrical power at the well site. Rough terrain made it impossible to build pump stations along the pipeline route. Parts of the design for the system were beyond the normal capability of the battalion's construction staff.

Reconnaissance

A map reconnaissance yielded two route options: the first went along a road that wound 2½ miles up the mountain's southwestern slope, the second climbed straight up the western side of the island. We sent a small site reconnaissance and survey team to Tiger Island to study the terrain and to locate a centerline for the project.

The team discovered immediately that the island's primitive environment would make construction a challenge. Thick vegetation on the upper slopes made the mountain a hooded monster; the lower slopes were covered with cornfields and open spaces that belonged to local farmers. The "road," nothing more than a donkey trail, offered neither access for construction nor reduced grade. The straight route up the mountainside would be best for the pipeline, we decided.

Omaha District, Corps of Engineers, helps with project design

Shortly after returning from the site visit, we contacted the Omaha District, Corps of Engineers. We explained what we had seen on our reconnaissance and our idea of how the mission might be accomplished.

The partnership we developed with the Omaha District project design team was critical to our success. Deployment training exercise project designs are normally carried out by the unit tasked with the mission or by the staff at Palmerola Air Base on the Honduran mainland. The complexity of this project required expert technical assistance which only the Corps could provide. Our joint effort to design and construct the pipeline yielded lasting benefits to both organizations.

By mid-February, the scope of the pipeline project had become apparent. Just to move water, the system needed an electrical supply system, an electromechanical control system, and hydraulic components. Terrain along the project site did not allow access for construction or maintenance. Multiple pumping facilities would greatly increase the required construction effort and also the potential for future maintenance problems. Therefore, a single pump station near the well site would be the best choice. The consequences of this design decision were unnerving—the static pressure head in our pipeline would be in excess of a thousand pounds per square inch.

The design team, now consisting of engineers from the hydraulic, electrical, mechanical, and structural areas, faced equally perplexing design problems. Our power source was over a mile away from the well site; therefore, an electrical distribution system was required.

Three-phase motors were the optimal choice because of their cooler operating temperature and longer life. These motors dictated the type of power we had to bring to the site. Two options were available—a high voltage system that used 2-gage conductors or a low voltage system incorporating 500 MCM conductors. The lighter weight of 2-gage conductors made a high-voltage distribution system the logical choice.

A control system was needed to

PVT William Walsh and SGT Edward Harris mix and place the pump station foundation. The trough shown served as the mixer for the entire placement. The white pipe protruding on the right temporarily protected the well from being contaminated or accidentally sealed.

operate the pipeline and to prevent or indicate component failure. We designed a system that could provide information on pump and motor status, prevent pump cavitation due to low water conditions, and remotely control the pumping cycle.

Getting supplies—getting there

Getting materials was our next obstacle. Construction materials for deployment training exercise projects are purchased locally in Central America. Most arrangements are made through the contracting officer at Palmerola. Our design efforts had produced a viable bill of materials, but what we needed to carry out the mission was not available anywhere in Honduras. We had to bring it from the United States. The responsibility for that task fell to the 52d's staff.

It took 3 months to write specifications, produce the necessary purchase documents, secure funds from USSOUTHCOM, obtain, and prepare nearly $100,000 worth of construction materials for shipment. We needed help from the Omaha District in preparing the specifications for everything from steel pipe to microprocessor control systems.

Transporting soldiers, materials, and equipment from Fort Carson to Tiger Island was an enormous endeavor. With careful airload planning, we managed to move the 50 tons of mission-essential materials on two C-141B Starlifters.

The materials and equipment were trucked from Palmerola to the small seacoast village of Coyolito. To our dismay, as materials were off-loaded in Coyolito, several 700-pound reels of cable rolled off a truck bed and crashed to the ground. Crates that had been specially constructed to store 21-foot sections of steel pipe were reduced to splinters, and pipe was scattered about the ground. Fortunately, no construction materials were damaged, and we managed to salvage enough packing material to take us over the next leg of our journey.

In Coyolito, our materials and equipment were loaded aboard an old barge operated by the Honduran Navy. We could only do this at high tide, when the barge could move close enough to the pier to be loaded. Even then, the motion of the barge and the narrow gangways proved tricky for our backhoe operator, who narrowly missed a trip into the drink when a plank broke under him.

Our troubles weren't over yet—as the barge neared the pier at Amapala, it ran aground. We rocked all night in the shallow water, waiting for the rising tide to free us. Townspeople lined the shore, curiously wondering what the American soldiers were trying to do.

Building the system

The first job on Tiger Island was to move materials to the work sites. Over the next 2 weeks, we flew about a third of our supplies to the top of the island in a Chinook helicopter. The remainder were stockpiled and secured at the pump station site.

Laying pipe. Placing and connecting the pipe proved to be the most demanding task of the entire mission. The project centerline, which had been surveyed and cleared only 3 months before by the reconnaissance team, was completely overgrown with vegetation. With the aid of a native farmer we reestablished the centerline, working for several days to reclear the route before any pipe could be moved into place.

Every available soldier worked for 3 weeks to place over 6,000 feet of pipe on the treacherous slopes of the

CPL Todd Browning, CPL Dennis Fitzpatrick, SSG James Dixon, and PVT Joseph Lininger begin to lower the submersible well pump and motor into the well casing; they lowered the apparatus 80 feet by hand.

mountain. Each section was moved and placed by hand, using human chains to pass the 70-pound lengths to their designated locations.

Coupling the pipe was a simple process. We used Victualic ® couplings and fittings, which allow about 3 degrees of flexibility in all directions at the point of coupling. The entire system was surface laid, so the couplings had to be flexible on varying terrain.

Laying electrical system. Installing the electrical distribution system also proved to be a challenge. On our initial site reconnaissance, we learned that the local farmers burn their cornfields twice a year to control pests and remove undergrowth. Obviously, the electrical system had to be buried, or the first burn would destroy it. First, all cable was surface laid by hand and spliced by high-voltage exterior electricians from Alpha Company. After the entire cable length was in place, 60 contract laborers spent 2 weeks in burying the cable. The rugged terrain made it impossible to dig in several places; instead, 7,000 sandbags covered the exposed sections.

Splicing the cable was a difficult task in the tropical environment. The cable had to be surgically clean and dry. The splices had to be made with extreme care, and each one tested for capacity to carry the high voltage for which the system was designed. This task, which included carrying heavy test equipment up and down the mountain, took 2 weeks. It was the last major activity necessary to complete the project.

Preparing the well site. Construction at the well site went on for the duration of the 2-month project. First, we removed the well pipe and submerged well pump that had been placed 2 years earlier. Extreme care had to be taken not to damage the well casing or drop the pipe. We then constructed a 15-foot-square concrete pad and foundation on which the pump house structure, pumps, motors, fittings, and controls would stand. There was no ready mix concrete, so we mixed by hand, using the 1:2:3 mix design method. Over the cured foundation, we erected a prefabricated metal building.

Our plumbers and electricians installed pumps, motors, interior electrical components, and the control system. At the same time, a second crew constructed an 8-foot-square structure at the summit to house an additional pump and the master control panel. At first, the control system did not operate properly. Apparently, one of the printed circuit boards in the control panels had been damaged during transport or installation. After several consultations with the manufacturer, we installed new boards, and the system began to function properly.

Lessons learned

Constructing this pipeline and pumping system was a challenge to the soldiers and leaders charged with the mission. Often, four or five separate construction projects would be going on in different places, as the project spread for a mile up and down the mountain. Continuous coordination was essential to accomplish many tasks because each was dependent upon others.

The ability, experience, and skill of the NCOs assigned to the project, as well as the determination and initiative of every soldier, were paramount in the success of this mission. We learned a great deal about ourselves, construction, and working in foreign environments. The Deployment Training Exercise program provided, without a doubt, the best individual and collective training available to engineer soldiers.

We learned several important points during this project that are worth sharing:

First, there is no substitute for well-conditioned soldiers. The engineer soldier must be physically and mentally conditioned to cope with the hardships that must be endured in adverse environments.

Second, both officers and NCOs must be able to understand the scope of the mission before they can carry out the subtasks so as to ensure the mission's success. Engineer leaders must give mission orders and allow subordinates to be ingenious and creative in their work.

Finally, units working on technically complex projects can benefit from the expertise and experience of members of the area and district Corps of Engineers offices to ensure the successful design, planning and execution of the mission. Engineers who understand the entire system, each subsystem, and the interfaces among them, must be an integral part of the design and system start-up process.

Raising a pipeline to the top of a 2,500-foot mountain may have been a tough job—but planning, cooperation, and the perseverance and dedication of engineer soldiers proved again that we engineers rarely find any job impossible.

CPT Jim Balocki is currently assigned to the 52d Engineer Battalion (Combat Heavy), serving as the Civil Engineer. He holds a BS degree from the University of Washington, and an MS from USC and is a registered professional engineer in Virginia.

1LT Michael Malsom is currently a platoon leader with the 52d Engineer Battalion. He is a graduate of Oregon State University and OCS.

Engineer Solution

Solution to Question #1

The data from the in-situ soil yield a grain size distribution graph (on DD Form 1207) from which you find these critical soil sizes:
D(85) = 1.46 mm; D(50) = 0.17 mm; D(15) = 0.026 mm

The data from the proposed filter soil yield a grain size distribution graph from which you determine these critical soil sizes:
D(85) = 10.7 mm; D(50) = 2.1 mm; D(15) = 0.2 mm

a. Determine whether filter soil is unable to wash through the CMP perforations:
D(85, filter)/hole diameter = 10.7 mm/9.5 mm = 1.1 > 1.0
Answer: Yes.

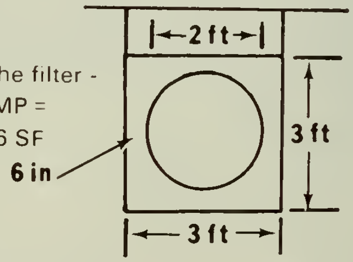
b. Determine whether in-situ soil is unable to wash through the filter:
D(15, filter)/D(85, soil) = 0.2 mm/1.46 mm = 0.14 < 5, and
D(50, filter)/D(50, soil) = 2.1 mm/0.17 mm = 12.4 < 25
Answer: Yes.

c. Determine whether there is sufficient permeability in the filter for free water to reach the pipe:
D(15, filter)/D(15,soil) = 0.2 mm/0.026 mm = 7.7 > 5
Answer: Yes, the proposed filter soil is acceptable.

Solution to Question #2

The thickness of filter material should be a minimum of 6 inches around the circumference of the drainpipe:

The cross-sectional area of the filter materials is calculated as—
Area enclosed by the perimeter of the filter - Area defined by the 24-inch CMP =
$3\ \text{ft} \times 3\ \text{ft} - (\pi/4) \times (2\ \text{ft})^2 = 5.86\ \text{SF}$



The volume of the filter material (well-compacted around the drainpipe) is the product of its cross-sectional area and its length:
2,000 m x 3.28 ft/m x 5.86 SF = 38,400 CCF
Since 27 CCF = 1 CCY, 38,400 CCF = 1,420 CCY

Considering losses of filter soil during loading, hauling, and placement, one should add a reasonable waste factor. A value of 10 percent of the volume is a sensible factor, so the project will require 1.1 x 1,420 CCY = 1,560 CCY of filter soil.

The S-2's estimate was for in-place soil. To convert the compacted volume of filter soil to in-place volume, multiply 1.05 x 1,560 CCY = 1,640 BCY.

Answer: You have enough filter soil to properly construct the drain.

Reference: Chapter 4, FM 5-541, *Military Soils Engineering*, May 1986.

Problem submitted by MAJ Randy Rapp, Staff Officer, HQDA, ODCSOPS, Force Development Directorate.

Army Well Drillers in the Rapid Deployment Force

by LTC Bruce A. Malson and CPT David O. Carberry

The Quartermaster Corps can transform foul muck into potable water. But surface water must be available before Quartermaster Corps personnel can go to work, and many areas have none. Desert operations, for example, require massive logistical support if water has to be brought in by pipeline or other means. The best option is to find water in the area of operations—often, well drilling is the right solution. Today's Army can put completely-equipped well-drilling teams on the ground wherever and whenever they are needed.

Reorganizing for rapid deployment

A focussed organization for well drillers has been reactivated in the Army after a post-Vietnam hiatus in service. Three of its active well-drilling detachments originated after 1980 and were assigned to the 548th Engineer Battalion (Combat Heavy) and Fort Bragg in June of 1985. The 6th Detachment is based in Panama.

The 22d Detachment originated at Fort Campbell, Kentucky, in January 1981. The 38th Detachment originated at Fort Riley, Kansas, in December 1983. The 865th Detachment originated at White Sands Missile Range, New Mexico, in October 1982. After attending several schools, including the Navy Well Drilling School, these units deployed to sites in the Continental United States and in Honduras, where they successfully completed numerous wells.

The Army drillers then consolidated at Fort Bragg to train and deploy. The past 15 months have witnessed deployments to four states and two continents. The result has been improved technical skills and ability to sustain operations. The Army's goal is to have three detachments that can deploy independently and sustain well-drilling operations for 15 days. The right repair parts are the key to sustaining operations. Through each training event the list of parts is refined. Simultaneous deployments to New York and Virginia in August 1986 validated the current repair parts over-pack and identified the few additions still needed.

Well-drilling team configuration

Since joining the 548th Engineer Battalion in June 1985, the well drillers have lived the battalion motto—"our jobsite—the world." They are on standby to go anywhere, anytime, to drill wells up to 1,500 feet deep.

Each detachment is authorized five personnel. The central piece of equipment is the drilling machine. The crew's most critical function is maintenance. "We are unique to the Army by virtue of our mission and equipment. We are our own mechanics. Each man must learn to break down every component of the drilling rig and rebuild it. Often isolated while doing our job, we must rely on ourselves," says SFC Wesley Turner, NCOIC.

The well drillers are organized into a platoon of three detachments. The platoon leader or sergeant accompanies a detachment on deployment. The detachment leader puts his crew to work conducting the actual drilling operations while the platoon sergeant or leader coordinates the mission.

How does the work really go? In a recent deployment to Fort Drum, "It became obvious that we would need additional bearings for the drill rotary table during a maintenance break. 1LT Sullivan was able to obtain them in one day while we carefully sustained the drilling, so no time was lost," explains SSG Dennis Huff, NCOIC of the 38th. "The detachment leader is the technical expert, the man who makes it happen. I keep him properly resourced and the wells go in," added 1LT Tim Sullivan, platoon leader.

Well-drilling operations

The unit's first action on site is to dig mud pits—two holes measuring 6 feet long by 4 feet wide and 4 feet deep. Mud is produced by combining a slurry mix with water. Its purpose is to prevent the well from collapsing during drilling, as well as to bring up debris created by the rotating drill bit at the well bottom. The mud's density is easily adjusted by adding more slurry mix or water.

Next, the soldiers prepare the drill rig and attach a drill bit. The size of the bit depends on mission requirements and geological conditions, but can be over 10 inches in diameter. When drilling begins, the drill rig can exert over 5,000 pounds of pressure to force the bit into the earth with a rotary action. A powerful mud pump pushes mud to the bottom of the hole through the drilling stems, forcing mud to surge up through the hole and then to the mud pits where sediments can settle out. The mud is then cycled back through the pump and into the hole to repeat the process over and over.

As drilling proceeds, soldiers take samples every 5 feet to record the drill's progress. The mud flowing out of the hole is strained for samples of the material that the bit is boring through. "This allows us to identify the aquifers. When we bring up rounded gravel and sand mixtures, it is a pretty good bet we have reached a water-bearing formation," explains SGT Steven Johnston, the 22d's NCOIC. The first sign that a good water source has been reached is often a marked reduction in the density of the mud. This indicates that ground water is diluting the mud.

The full five-man detachment works together to establish drilling operations. Within 12 hours of arriving on site, the soldiers are operating the rig in round-the-clock drilling. Two-man shifts work 12 hours each. The rig stops only for maintenance, which takes up 4 to 6 hours a day. While two men work, the two or three others perform peripheral support tasks—picking up supplies or catching some sleep. Because the current organization is so physically demanding for the crew, the modification table of organization and equipment (MTOE) is currently being reviewed to consider authorizing nine personnel for each detachment.

Finishing the well

An important part of the well drillers' mission is finishing the well. This includes emplacing steel casing through the depth of the hole—a gravel packing around the entire length of the steel casing—emplacing the pump and galvanized steel pipe to carry the water out of the well, and a sanitary cement cap around the top of the well.

First the soldiers ream the hole by blowing air through the drilling stems. The air rises, forcing debris up and out. When the hole is relatively free of debris, the crew puts casing in the hole. The 20-foot sections of steel casing include screens that let water into the well. Next, the soldiers pack pea gravel (⅜-inch-diameter gravel), around the outside of the casing all the way to the bottom. They then set the pump within the casing, and install a sanitary cement cap around the top of the well. Finally, the crew adds electrical power with a generator, and the well is ready to produce water.

The material used to finish wells comes from a well-completion kit. Kits are currently stocked in Pueblo, Colorado, awaiting contingency missions. Each kit requires six to eight tractor-trailer rigs for transportation. Each contains materials to finish almost any size well to a depth of 1,500 feet. Adjunct equipment includes a 30-kilowatt generator and various size water pumps. In the event of a deployment, this kit is shipped to the drilling site.

Finding water

Well-drilling engineers are not trained to select sites for water-producing wells. During Bright Star 85, an Army geologist was responsible for selecting a site location. Geological survey maps are used when possible, but often the most valuable source of information proves to be local inhabitants. By asking about existing wells and their depth, the well drillers have a little more to go on. If no information is available, well drillers make an estimate by studying the local geography and then recon by drilling.

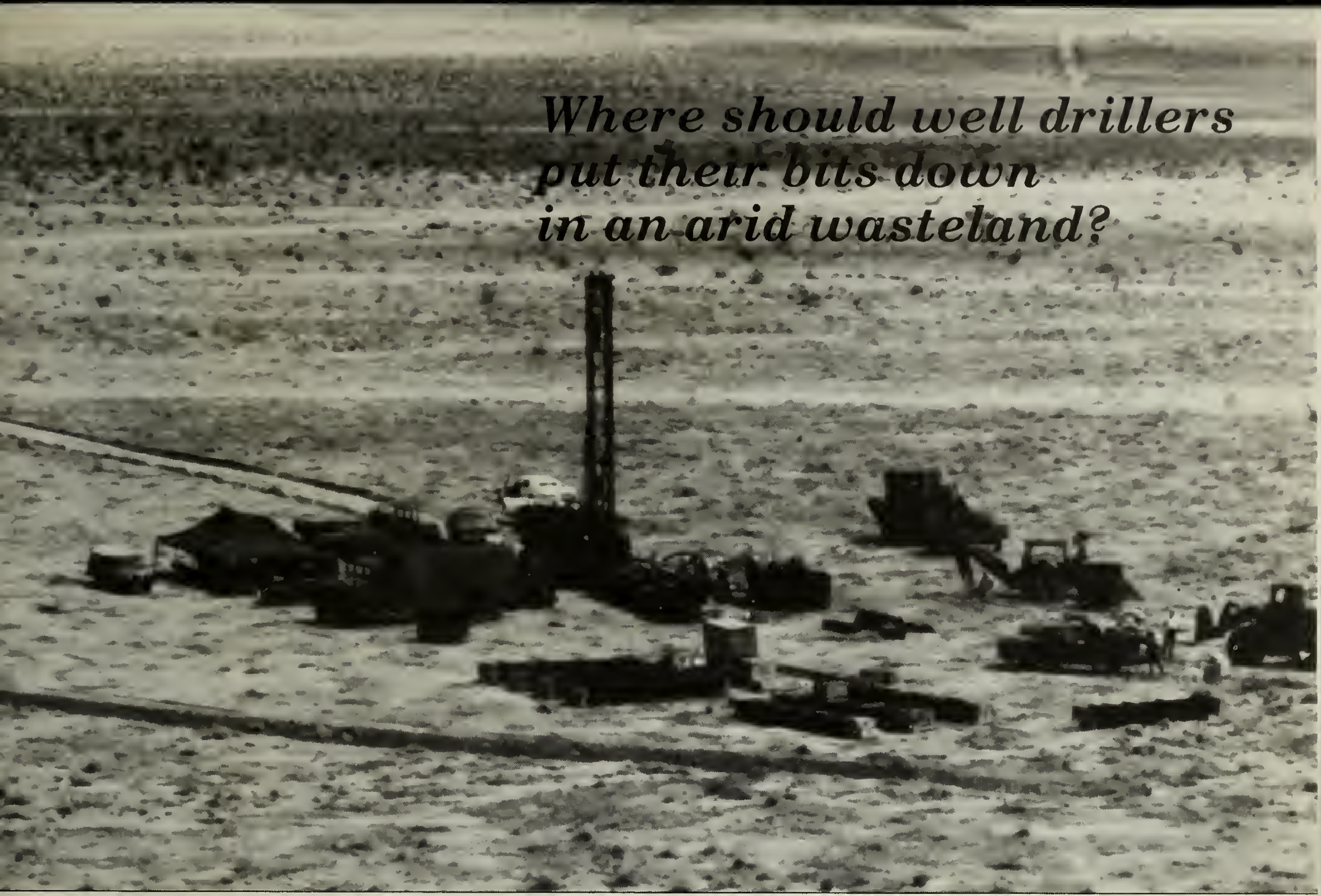
Lighter equipment planned

The future promises new equipment for well drillers. Detachments will be refitted in FY 88. The proposed rigs will be capable of drilling to 600 feet, and will be transportable with C141 aircraft. This provides a significant advantage over current models that drill to 1,500-foot depths, but require C5A aircraft for transport.

Today and every day, the 22d, 38th, and 865th stand ready to go anywhere to perform their mission. Their four reserve counterparts are also available for well-drilling missions. The story of the well drillers is one of increased readiness for arid area operations. After 2 years of training and deploying from Fort Bragg, they can say to the Army: ***We're ready to produce oases on order!***

LTC Bruce A. Malson is the deputy commander of the 20th Engineer Brigade at Fort Bragg, North Carolina. He previously commanded the 548th Engineer Battalion (Combat Heavy). Before attending CGSC, LTC Malson served in the 237th Engineer Battalion in Heilbronn, Germany. He is currently completing a PhD at New York University.

CPT David O. Carberry commands Company A, 548th Engineer Battalion. He served as platoon leader and company Executive Officer with the 82d Engineer Battalion in Bamberg, Germany. He holds a BS in mechanical engineering from Clarkson College of Technology, and is an EOAC graduate.



Where should well drillers put their bits down in an arid wasteland?

Water in the desert

by CPT Michael G. Monnett

Gone are the days of "water discipline" when we thought soldiers could teach their bodies to make do with less water. We have learned that soldiers in training and combat need plenty of water to survive, fight, and win.

This is particularly true for soldiers operating in hot, arid environments like the one the U.S. Central Command (USCENTCOM) worked in last summer during Gallant Eagle 86. Held in southern California in July and August, Gallant Eagle 86 gave interservice forces an opportunity to deploy, conduct, and support sustained joint military operations from multiple locations in a desert environment.

Like any other desert operation, this exercise had a big thirst. One way to get water was to drill wells—but where should well drillers put their bits down in an arid wasteland?

THE WATER RESOURCES SUPPORT TEAM

Mr Allen DeWall, team leader for the Water Resources Support Team, Terrain Analysis Center, Engineer Topographic Laboratories, Fort Belvoir, VA, supplied the answer. "We support Army operations by sending a research team to find areas that have a high probability of containing water."

To carry out that mission, the team has a geologist, hydrologist, and geophysicist, and is broken down into four elements. The data base element looks at existing water resources. The remote sensing element analyzes imagery to determine probable water sites. The geophysics element provides the main effort at the location. The fourth element is someone familiar with the local area and the language of the natives.

For Gallant Eagle 86, the team deployed to Fort Irwin, CA. Its mission: find water for a joint drilling operation by the 425th Engineer Detachment, an Army Reserve unit from Dallas, TX, and the 820th Civil Engineer Squadron (USAF), Nellis Air Force Base, Las Vegas, NV.

Imagery survey—

Before the team deployed, its members looked at all available imagery—satellite or aerial photos, maps, and surveys. "Where there's life, there's water," DeWall said. "We look for drainage patterns, springs, anywhere water might go underground."

In some of these areas the team also looks for indications of fault lines. Water tends to travel down faults, and where they intersect, there's a good chance water has collected.

Resistivity testing—
Once on the ground, the team goes to each likely source of water and conducts electrical or magnetic field resistivity tests. If there is water in a formation, resistance is lower. If the water is salty, it's far lower; if the aquifer is dense—clay, for example—resistivity is higher.

There are two methods of measuring the resistances of strata underground. The older method, called electrical resistivity, consists of sending an electric current through the ground and then recording the return, much the same way a meter can read the amount of current passing through resistors in a circuit board.

The other method, Transient EM, is much newer. "Instead of generating a current through the ground, Transient EM creates a magnetic field," DeWall said. "When the current that creates the field is shut off, the field collapses, generating another current in its wake. We measure that current as it dissipates into the ground."

THE DRILLING SITE

At Gallant Eagle, the team chose a closed basin where the water was likely to flow in from all sides. They felt almost 100 percent sure of hitting water here, since there were two existing wells in the area. The water they expected to find had collected over many years to form an underground lake, or aquifer.

The process of finding water, however, is never a certainty. "All we can deal in is probabilities," DeWall cautioned. "We can say that there's an 80 percent probability that a location has water, but we just don't know unless drilling is successful."

To drill and find nothing is not an infrequent occurrence. As for the team at Gallant Eagle 86 site, the water rising at the desert well was ample evidence that their search techniques could be real thirst quenchers.

The only sure way to find out if a formation holds water—drill for it!

CPT Michael G. Monnett was commissioned as an Air Defense Artillery Officer in 1987. He has served with the 82d Airborne Division at Fort Bragg, North Carolina, and with the 32d Army Air Defense Command in Germany. He is currently commander of the 13th Public Affairs Detachment, Fort Hood, Texas.

Repairing Historic Gold Camp Road

The worst washouts had eaten 25 feet into the road's outer edge; they bottomed out anywhere from 40 to 70 feet below the road

by 1LT Jeffrey P. Lee

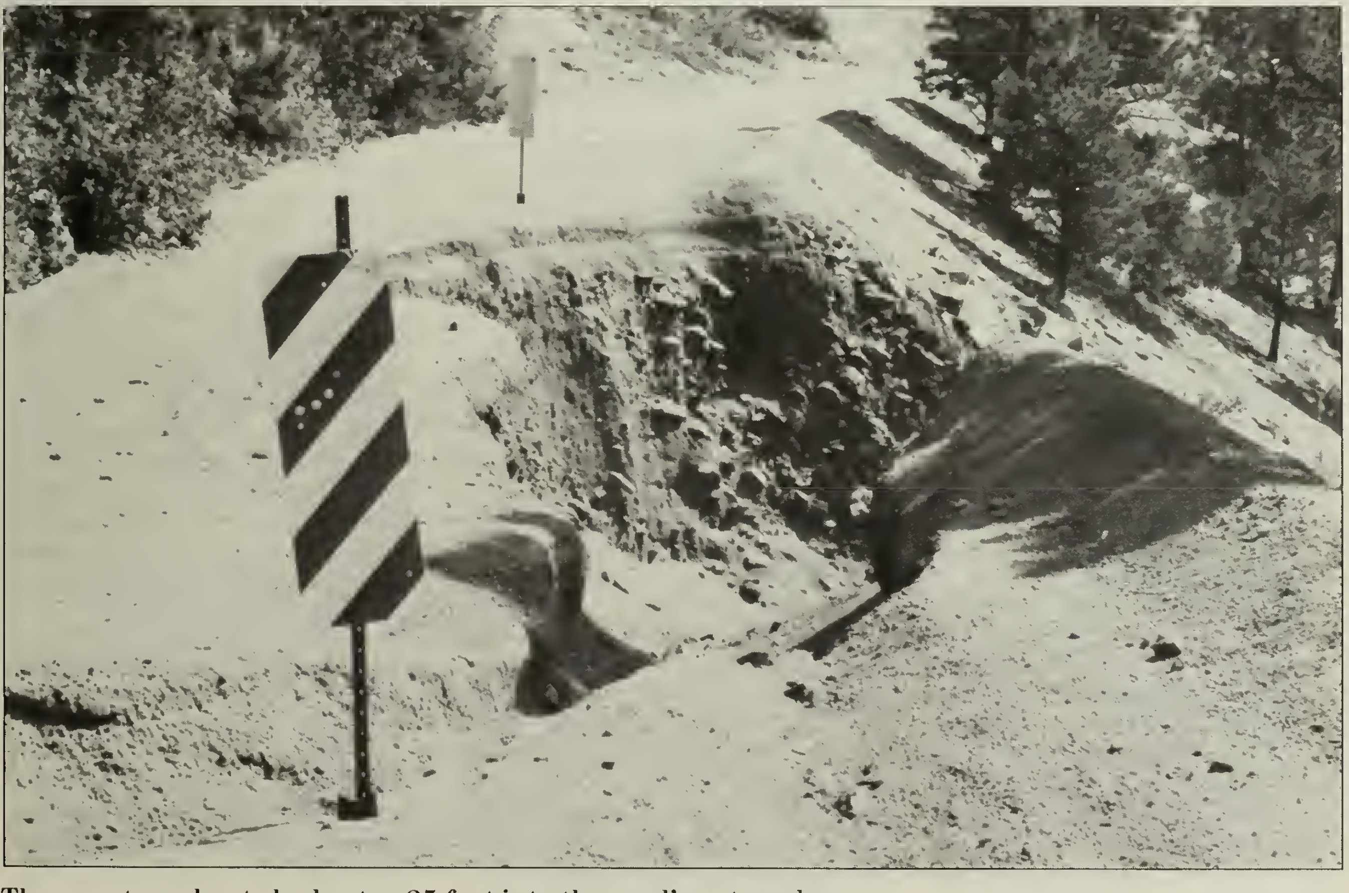
Five relentless hours of summer rain pour 8 inches of seething liquid erosion onto a crumbling mountain road—could you repair the damage quickly if that road was a critical line of communication? C Company, 52d Engineer Battalion (Combat Heavy) of Fort Carson, Colorado, found they could.

Seven miles of Gold Camp Road had been closed for nearly a year after just such a storm. At the request of the U.S. Forest Service, C Company repaired the damage and completed a new drainage system in just 3 weeks, reopening the road for travel in August, 1986.

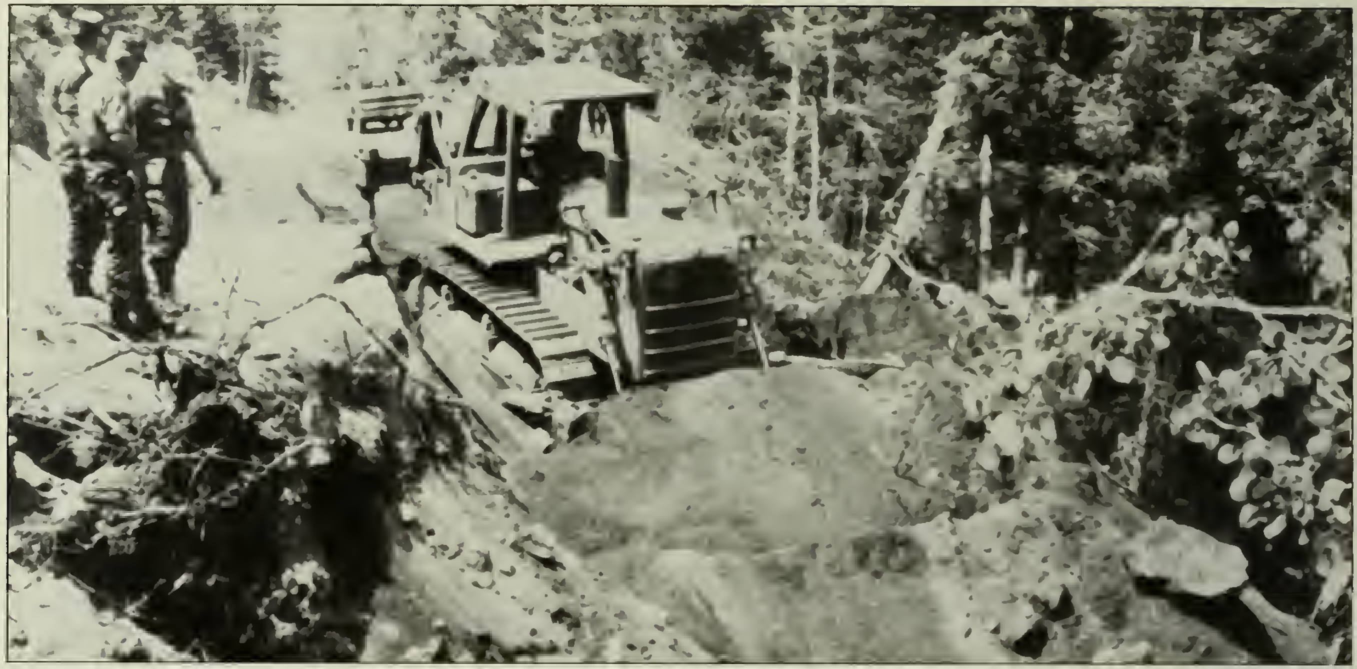
Originally built as a standard gage railroad in 1901, Gold Camp Road hauled the half-billion dollars of gold ore mined at Cripple Creek, Colorado. The 45-mile-long railroad ran to Colorado Springs at a 3.8 percent grade. It boasted 9 tunnels and 31 trestles. This made it the steepest standard gage railroad—and the most expensive—of its time.

The railroad also attracted a booming tourist business. Its most famous rider was Vice President Teddy Roosevelt, who called his scenic passage "the trip that bankrupts the English language."

After the Cripple Creek lode played out and the train stopped running, a Colorado Springs businessman bought the railroad for its tourist potential. He tore out the trestles



The worst washouts had eaten 25 feet into the road's outer edge.



A D-8K dozer built a pioneer road to gain safe access to the bottom of each washout.

and tracks, making the route into a toll road. In 1939, the road became a free highway known as Gold Camp Road.

The U.S. Forest Service and El Paso County have maintained Gold Camp Road ever since. But when they found contract repair of the 1985 washouts would cost an estimated $250,000, it became clear the road would be repaired later—or never. Then the Forest Service turned to the U.S. Army engineers.

Assessing the damage

The damaged section of Gold Camp Road was comprised almost entirely of weathered and disintegrated granite. The road grade rises smoothly, consisting of an unusual amount of cut and fill construction along the contour of the rugged mountains—the railroad's builders chose to work along mountainsides and canyon walls, rather than along a streambed.

The through fills were the most fragile. Eleven washouts—five of them major—had occurred along the road. The worst washouts had eaten 25 feet into the road's outer edge; they bottomed out anywhere from 40 to 70 feet below the road surface. Washouts occurred where the inslope of the road reversed and the outside edge of a through fill eroded, leaving huge chasms in the road (two of these were only passable by trail bike).

It was critical to redirect the drainage—otherwise new washouts would occur.

The culverts had almost all failed. Built perpendicular to the road at a 2 percent slope and at small diameters (18 inches), most were choked with disintegrated granite.

The disintegrated granite had very few fines and was extremely susceptible to erosion. This soil was made up of Pike's Peak granite, a soil that correlates to a Unified Soils Classification System type SP. In its unweathered state, the granite is characterized by large phenocrysts of flesh-pink microline in a ground mass composed of quartz, oligoclase, and abundant biotite, with numerous trace minerals.

Working closely with a U.S. Forest Service Civil Engineer, C Company decided to install 25 culverts, construct 16 rolling dips, grade 7 miles of road, dig ditches, and repair all washouts.

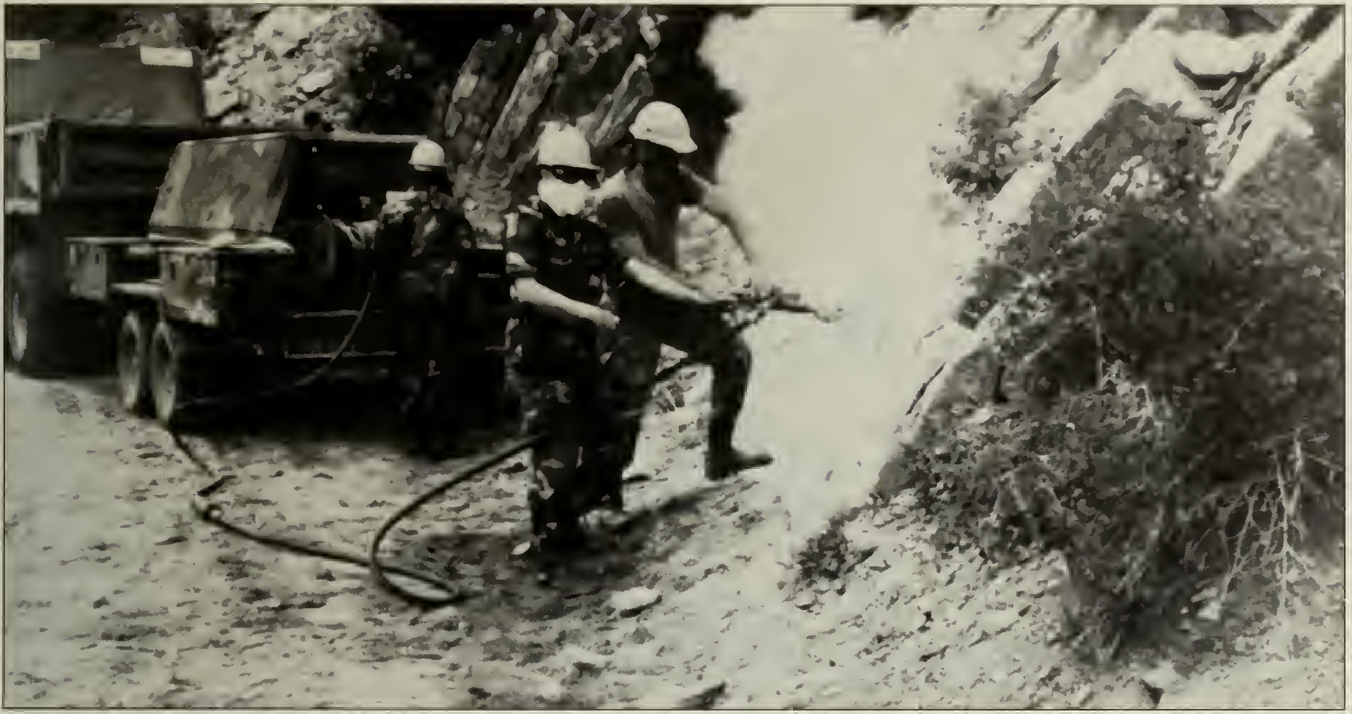
Rebuilding the road

C Company deployed almost all equipment and personnel from the Heavy Equipment Earthmoving Platoon. The company was supported by two general construction squads, two mechanics, a mess section, and a medic. The unit set up a bivouac at the project site.

The Forest Service supplied culvert and explosives. The Forest Service's civil engineer also surveyed borrow sites, culvert locations, and washouts in coordination with the 52d's staff and surveyors.

Work began immediately on the three largest washouts. A D-8K dozer built a "pioneer road" to gain safe access to the bottom of each washout. Once trafficability was established around each work site, the D-8Ks and MW-24 bucket loaders opened borrow sites, and the M-929 5-ton dump trucks began haul and fill operations. Engineers placed boulders carefully to build shelves from the washout bottom upward, filling voids in the shelves with disintegrated granite material. Using a 6,000-gallon water distributor and a K-300 high-speed compactor (BOMAG), they added moisture and compacted the material in layers 1 to 2 feet deep.

The 52d repaired all washouts this way. Soldiers used a nuclear densometer to test compaction. Samples taken at most sites surpassed the 90-percent CE-55 goal, and often reached 100 percent compactive



Soldiers drill 4-foot-deep holes in granite for demolition charges.

effort. The few sites that were below specifications were reworked to meet the 90-percent goal. The unit nearly doubled the road width at each washout and raised the outside shoulder to create an inslope—this would carry water past the repaired washout. Workers also excavated the inside wall to widen the road and create an insloping surface.

Demolition served to loosen more rock at high elevations in the borrow site, to widen the road through solid rock outcroppings, and to open space for a culvert in solid rock. The unit arrived at a suitable charge after initial tests showed that civilian explosives were relatively weak. The unit used two-component explosives ammonium nitrate and nitromethane. Soldiers drilled holes 1¼ inches to 1½ inches in diameter with a 250-cubic-foot-per-minute air compressor and rock drill. The most effective charges were set 4 feet deep and weighed 4 pounds each. These charges were placed along natural joint patterns and in structural deformations, to take advantage of weaknesses in the rock formations. The charges were packed and tamped with moistened soil.

It was critical to redirect the drainage—otherwise, new washouts would occur. The 52d insloped the entire stretch of road to protect the fragile through fills. They used 130-G graders except on the upper, rockier sections, where D-8K dozers cut the initial rough inslope.

The unit installed culverts where existing culverts had failed or where drainage already flowed from the inslope to the outer shoulder. To enhance self-cleaning of disintegrated gravel, the engineers set the new culverts at a 10-percent slope and at an angle instead of perpendicular to the road. The new culverts were also 24 to 36 inches in diameter—wider than their predecessors. The unit placed culverts in stable natural drainage channels. The inlets were covered to a depth of at least half the culvert's diameter, and both inlets and outlets were riprapped with granite. A D-8K dozer with a single ripper dug culvert trenches in rocky areas; otherwise, a backhoe was used. Culverts became the most time-intensive aspect of the project.

The engineers built rolling dips with a 621-B scraper. The scraper excavated the outer shoulder and used the fill to build a berm just below the dip. A grader worked the material into a crest to prevent water from passing the structure. The rolling dip would then act as a culvert, forcing the insloped drainage across the road to exits in level areas that would allow water to dissipate naturally.

Upper stretches, where rough rocky outcroppings were the road surface, were resurfaced using 621-B scrapers to spread lifts of select disintegrated granite material. Final work included leveling and landscaping all borrow sites. Damaged trees were removed and culvert inlets cleaned and widened.

On August 7, 1986, Gold Camp Road reopened. The 52d finished the project on schedule in just 26 days, 23 of which were spent on construction operations. The equipment-intensive project gave operators and supervisors invaluable experience of engineer tasks they'd have to perform in a wartime mountain road construction or repair mission.

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Engineer Cellular Teams

by CPT Steven R. Steininger

Some specialized tasks are beyond the capability of standard unit organizations. For these tasks, the Army has created the Engineer Cellular Teams (TOE 5-500 series) to be employed on an "as-needed" basis in any theater.

The TOE 5-500 Series

The complete Tables of Organization and Equipment for these units are often hard to obtain in the field. Field Manual 5-100, *Engineer Combat Operations*, describes many of the cellular teams. This article focuses on construction-oriented teams: TOEs 5-520-H and 5-530-H. Several common planning factors affect engineer teams, and should be known to commanders and staffs alike.

Construction team planning

Some engineering missions of the combat heavy battalions will be deleted when they reorganize in mid-FY 88. The Army recognizes the importance of retaining such engineer skills as quarrying and paving, forestry, power distribution, and diving. But we cannot dedicate units to these missions in every brigade or battalion.

Some cells deserve separate discussion, but most share common resource and management needs—especially maintenance, supply and logistics, and personnel and administration. All have some operational limitations. To integrate a detachment successfully, managers must contact the cellular teams and investigate their needs.

Maintenance. Some of the larger detachments have an organic maintenance crew. Often the crew (or mechanic) works only on equipment unique to the team. Repairs to engineer vehicles and equipment (radios, weapons, cargo trucks) must be made by some other element.

The simplest way to deal with maintenance needs is to attach the team to a support or line company. This approach challenges the supporting company—the organizational shop is now responsible for more equipment and vehicles. The prescribed load list (PLL) will be drained faster, so stocks should be beefed up before a team arrives, and needed PLL item lines should be added to accommodate unusual equipment needs.

A bigger workload means the direct-support shop has to alter its scheduled services. Priorities will change (Engineer teams have a high visibility—everyone wants to see them work). Leaders will have to be resourceful to overcome the challenges without seriously hampering operations or affecting morale.

Special detachments can also be sent to the team from the direct-support shop. This works well when the team is away from its support unit. Problems can arise with POL and PLL supply and personnel and tool loss to the direct-support shop.

Logistical support. Since many teams have no organic supply sections, cellular teams are totally dependent on the unit to which they are attached for logistical support. This is true of all classes, especially Classes III, IV, V, and IX. POL is a major item. Heavy equipment burns diesel fuel quickly, and requires quantities of lubricants and fluids, some of which are unusual.

Major end items (Class VII) may also present challenges. If an indispensable element of the team's system becomes a total loss, the whole operation may collapse unless a suitable replacement is available.

Detailed coordination and planning that includes representatives from operations, logisitics, and maintenance can forestall crises by ensuring that a team and its support unit are not hampered by supply interruptions.

Personnel support. Personnel support and administration often get overlooked. Contact between the S-1 (XO/1SGT at company) of the host unit and the inbound attachment is critical. For the duration of an operation, a team is dependent on the unit to which it is attached for finance, replacements, personnel actions, and for legal, mail, religious, medical, and food service. Nothing is so painful as a soldier with a problem. An early list to the S-l (XO/1SGT) of names, rank, SSN, MOS, and next of kin can avoid trouble later.

Security. Several common threads also run on the operations side. Teams do not have crew-served weapons. Their only self defense is small-arms fire. If a team is to be included in a larger defense plan, remember its limits. If weapons are provided, training must be provided too.

Camouflage and NBC are another grave concern. Only a few teams can conceal themselves. This is partly because they have no screening systems, but mostly because of the nature of their work (quarries are hard to hide). These engineer crews are highly susceptible to attack. Most are equipped to detect NBC weapons and protect their people, but not to decontaminate and/or continue operations in an NBC environment.

Communications. Although some cellular teams have organic communications, many do not. S-3s like teams to have radios. Communication gear and personnel are prized commodities throughout the Corps. It is likely that the supporting unit will have to give up gear, if outside assets are not brought in.

Transportation. Some units have enough vehicles; some can hardly even move their people. Most require assistance—much of the machinery is oversized and has special movement problems. A few items will not fit on any available USAF planes. Transport planning must start early.

Cellular teams

The teams designated under the 5-520H/530H TOE series are built to work in forestry, quarrying, well drilling, concrete paving, equipment support, pipelines, power lines, power plant operation/maintenance, asphalt mixing and paving, diving, utilities, and real estate.

Engineer teams perform many integral unit functions. The tasks that set them apart can be found in ARTEP 5-500, *Engineer Cellular Teams*. Though aging, it still provides good information to the operational planner. ARTEP 5-115, *Engineer Combat Heavy Battalion*, will define quarrying and asphalt missions until a new ARTEP 5-500 is published. Some detachments deserve a closer look.

Forestry. Attached to an engineer group, a service and support battalion, or operating semi-independently, this platoon-size section produces rough lumber and timber piling. It cannot deliver its products without added transportation support. With small maintenance and supply crews, the forestry crew functions better.

Quarry. Only the 225-ton-per-hour (tph) quarry unit is currently organized as a team. Once the combat heavy battalions surrender the remaining 75-tph sets, another quarry team will be created (2 capacities will be available until standard new equipment is in place). Both types are similar to current 75-tph squads found in the combat heavy units. Actual sizes of specific machines vary.

All units require transportation support and need numerous trips to haul everything. The 225-tph crush/screen/wash unit exceeds USAF capacity. Quarry units are normally attached to an engineer group, but can be expected to move down to battalion level in the future.

Well drilling. These are some of the most active teams today. For a complete picture, see "Army Well Drillers," on p. 23.

Concrete mixing and paving. Normally attached to a combat heavy battalion or construction support company (CSC), this team has its own 100- to 125-cubic yard-per-hour (cyh) central mix plant, a 200- to 225-cyh central mix plant, a 200- to 225-cyh slip form finishing machine, and organic maintenance. The team does not, however, have all the laborers needed to run a concrete operation. Added transport is needed to move the finishing machine.

Equipment support. These one- to two-man teams with either a dozer, scoop loader, or grader can be attached to engineer line companies working with maneuver units. All require support because of their size.

Asphalt paving and mixing. Two new cells are now available. One is the asphalt mixing team, built around the 100- to 150-tph asphalt plant, which produces asphalt cement concrete (ACC). It requires significant time, labor, and support to transport and erect.

The second is the asphalt paving team. It primarily places hot mix ACC to yield a quality surface for roads and airfields. The team can place cold mix materials and support bituminous surface treatment operations. Although it is self-mobile, the cell lacks dump-truck assets to move paving material. Both teams will be attached to groups, battalions, or CSCs.

Diving. Diving detachments may be placed almost anywhere, but normal engineer assignment is to a group or brigade involved in major port or underwater pipeline projects. The teams can dive in both SCUBA and deep sea underwater surface-supplied diving equipment in support of numerous tasks. These teams are currently under reorganization—organic sections in fixed units will disappear and become part of the modular concept.

Utilities. These cells sustain base-camp operations and fixed installations by providing facilities and engineering (FE) support. Three teams—HD, HE, and HF—are designed for installations of up to 2,500, 2,500-4,000, and 4,000-10,000 personnel. The teams have some construction capabilities, though their main mission is to maintain existing systems, health, and welfare. They can also maintain their own equipment. All are found in facilities engineer groups (TOE 5-203J) but may also appear elsewhere.

Power Line. Since the power distribution section of combat heavy support companies is disappearing, this team will take over general engineering tasks such as airfield lighting systems and exterior electrical distribution. Normally allocated to an FE group or power generating plant (often with team HG, Power Plant Generation and Maintenance), these high-voltage specialists may be attached to combat heavy battalions.

Other Construction Teams. Teams HC (Real Estate), HG (Power Plant), and HJ (Welding Inspection) also assist the construction effort. Their contributions are often critical to overall success.

Engineer cellular teams deserve more attention. As the role of the component-like detachments increases, we must learn to integrate them smoothly into other units. The thinking behind the teams is good: If commanders, staffs, and planners manage them correctly, cellular teams can make vital contributions to engineer missions.

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Hotline Q & A

Q. How can my unit obtain the Engineer regimental crests? How should the crest be worn with the uniform?

A. Corps crests are currently only available through the Army-Air Force Exchange System (AAFES) military clothing sales stores. If a unit desires to purchase crests for its soldiers, it should place a local purchase order with an AAFES clothing store. Units may also contract with private vendors; however, crests may not be purchased with appropriated funds. Ultimately, enlisted personnel will receive the crest as part of their initial issue through the supply system.

Males must wear the crest centered and ⅛ inch above the top of the right pocket flap or ½ inch above unit awards or foreign badges on the Army green, blue, and white uniforms. On the blue mess uniform, the crest is worn centered on the satin facing and ½ inch below the notch in the lapel. On the white mess uniform, it is worn ½ inch below the notch and centered on the lapel. The vertical axis of the crest must be perpendicular to the ground.

Females will wear the crest centered and ½ inch above the nameplate or ½ inch above unit awards or foreign badges on the Army green, white, and blue uniforms. It is worn centered on the right side of the white, blue, and black mess jackets between the lapel and shoulder seam with the top of the crest aligned with the top row of miniature medals. On mess uniforms the crest is not worn on the lapel or the lapel facing. The vertical axis of the crest will be perpendicular to the ground.

All members of the Corps who have completed advanced individual training, warrant officer certification, or engineer officer basic course are authorized to wear the crest. All personnel who held an engineer MOS before 23 June 1986 are automatically members of the Corps and authorized to wear the crest.

Q. How can my unit get an 80-foot timber trestle training bridge? Can this bridge be requested by national stock number?

A. The Engineer School's Department of Military Engineering, Bridging Branch, responds that the costs and national stock numbers for trestle training bridges are available in Army Facility Components System manuals. Although plans for an 80-foot bridge are not available, the costs for a 60-foot span and for two 40-foot spans with intermediate support appear below.

- A 60-foot steel stringer span, military load class 60, timber pile abutments:

#85120AE	Superstructure	$48,129
#85120CJ	Abutments (2 ea)	7,872
Total Cost		$56,001

- Two 40-foot glue laminated stringer spans, 2 lanes, military load class 60, timber pile intermediate support abutments:

#85120BG	Superstructure (2 ea)	$110,656
#85120EW	Intermediate support 20 feet high	4,720
#85120CJ	Abutments (2 ea)	7,872
Total Cost		$123,248

These amounts are in 1986 dollars as referenced from TM 5-301-1, *Army Facilities Component System-Planning (Temperate)*, pages 10-56.

Q. When M-1 tanks cross an AVLB 60-foot span bridge, do the curbs have to be removed?

A. The curbs remain on the bridge to guide the vehicles across. The maximum span of the AVLB is 15 meters for support of M-1 tanks.

The Three-Phase Inspection System— The Corps Guarantee of Built-in Quality

by CPT Thomas P. Reed

The U.S. Army Corps of Engineers has been in the construction business since the birth of our nation. Fort McHenry and Fort Meigs—sturdy monuments of the Corps' reputation for excellence—date from before the War of 1812.

Today, the Corps of Engineers' work includes a broad variety of civil and military construction projects, and a comprehensive system of quality assurance for its worldwide construction program. Billions of dollars worth of structures now uphold the Corps' standard of excellence in dozens of nations.

The three-phase inspection system is an important part of the Corps' quality assurance program. Common practice in the construction industry, the system is simple to understand and to implement. It can be applied to any construction project regardless of its size or complexity.

The three-phase system

The three-phase inspection system includes a preparatory, initial, and follow-up inspection:

The preparatory inspection. The first and most important phase of the three-phase inspection system is the preparatory inspection. It takes place before each distinct feature of the project is begun. In this phase, the supervisory and quality control personnel agree on the plans and specifications. They review construction methods, and ensure that personnel, equipment, and available materials comply with the project specifications.

Inspectors review plans for quality control tests or samples, and any documentation—such as certifications of the quality of materials to be used. They inspect the work site, and settle all issues surrounding plans, personnel, equipment, and materials before construction begins.

The initial inspection. The second phase takes place as construction begins. Inspectors take samples, perform control testing, and examine the work to ensure that the quality of construction is in accordance with plans and specifications. Construction methods can be adjusted to meet time limitations or other conditions that arise during the initial inspection.

The follow-up inspection. The third phase of the inspection goes on continuously until the construction sequence is complete. The work is inspected daily, using the same procedures established during the initial inspection. Deficiencies are corrected immediately.

A typical project

Here's how the three-phase inspection system is implemented by an engineer squad as they build a concrete tank pad. This project—like many other engineer construction tasks—requires prepared formwork and placement of concrete.

A three-phase inspection has already assured the formwork is adequate. The second sequence will be concrete placement. A day before the ready mix concrete is delivered and placed, the platoon sergeant holds a ***preparatory inspection*** with the squad leader.

During this inspection, the platoon sergeant reviews the requirements for concrete, personnel, and tools. He ensures that the process for placing, finishing, and curing the concrete will be in accordance with the appropriate technical manual (FM 5-742). He decides with the squad leader how many sample cylinders and slump tests are to be taken. Finally, the squad leader and platoon sergeant discuss any questions or doubts either may have about the concrete placement.

The platoon sergeant conducts an ***initial inspection*** during the first concrete placement. He ensures the methods used to place, finish, and cure the concrete are proper. He also checks the concrete's temperature, slump, and drop height. The squad leader takes sample cylinders as planned in the preparatory inspection. This inspection is complete after the methods used to place, finish, and cure the tank pad are verified.

The platoon sergeant conducts a daily ***follow-up inspection,*** continuing to monitor the temperature, slump, drop height, and the quality of the finish for each concrete placement. The squad leader continues to take samples on a regular basis. His test cylinders are broken 7 days and 28 days later to check the strength of the concrete.

The result?—a structure guaranteed to stand up under the wear and tear imposed by heavy loads.

The three-phase inspection system provides a systematic approach for quality control. It assures quality products by requiring detailed preparation, review, and inspection of each step toward a completed structure—whether that structure is as simple as a sidewalk—or as complex as the Grand Coulee Dam.

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Rome Plows easily felled trees in the dense Vietnamese jungle.

falling limbs, trees, and brush. This tractor and blade, soon known all over Vietnam as the "Rome Plow," became the mainstay of tactical land-clearing units in Vietnam.

The Rome Plow's blade was supported by shoes mounted on the bottom of the blade. Thus it rode about 6 inches above the ground, eliminating standing vegetation but not pulling up the roots or digging into the earth. The Rome Plow could slice through a 12-inch tree with one pass. Repeated passes by the knife-like stinger mounted on the left side of the blade felled trees up to 48 inches in diameter.

Land-clearing units

The Rome Plow force grew from the original four test plows of 1966 to three platoons, each with thirty plows, by the summer of 1967. In January 1969, the force reached its peak strength—six full companies with thirty plows each. Three of these companies operated independently under the 18th Engineer Brigade and supported I Field Force in the central highlands of Vietnam. The other three companies formed the 62d Engineer Battalion (Land Clearing) under the 20th Engineer Brigade, and supported II Field Force in the lowlands north and northwest of Saigon.

The 62d Engineer Battalion was designed to work in the large tracts of relatively level jungle found in the III Corps Tactical Zone, an area with a well-established road net and a large force of enemy soldiers.

The tactical land-clearing concept directly addressed the need to operate on Vietnamese terrain; its success owed much to the fact that techniques and doctrine were tailored in the field. The Rome Plow companies' organization, for example, was based directly on results of the field tests run in 1966.

These tests showed that platoons had too little maintenance support and too few operators to use an optimal number of plows. Since adequate maintenance was clearly critical for successful operations, the land-clearing companies formed in 1967 were given adequate organizational and direct-support maintenance. The company organization included enough operators to keep thirty tractors functioning.

Tactical operations

Land-clearing operations were of two kinds—area cutting and strip cutting. These operations fit two missions: 1) Clearing extensive areas of vegetation to deny cover where enemy activity was suspected, and 2) Clearing vegetation along roadways, trails, airfields, and installations to provide observation and fields of fire and to reduce the danger of ambush.

Area cutting operations. Area cuts were aimed at enemy supply and base areas and infiltration routes, and were usually conducted by company-size units. Guided by an officer in a helicopter overhead, a plow operator cut an outline of the area to be cleared. The other tractors followed counterclockwise around the delineated area, forcing debris to the outside. Using this method, a land-clearing company could clear 150 to 200 acres a day, depending on enemy action, the terrain, and maintenance problems.

Strip cuts. Strip cuts helped secure lines of communication (LOCs) and installations by clearing the jungle for 200 meters on either side of roads and trails or around base areas.

Security measures. Land-clearing companies had to provide themselves with flexible bases for operation. They established a nightly defensive position (NDP) with centralized maintenance and resupply at each project. New NDPs were cut as work progressed so that the tractors would not have to "walk" more than 4 kilometers to the work site.

The enemy was a constant and formidable problem to land-clearing units, which, lacking defensive manpower, relied on infantry or armor units to provide work-site security. The 62d Engineer Battalion (L/C) found that land-clearing operations worked best as coordinated engineer-infantry-armor operations. The unit posted two infantrymen on the lead tractor during operations to recon the jungle by fire.

Rome Plow operators often found themselves clearing the jungle far ahead of their infantry security. They carried .45-caliber submachine guns to protect themselves against enemy attack, since the standard issue M16 was too long for the enclosed cab.

Most casualties suffered by land-clearing companies were inflicted by mines, booby traps, and mortar attacks on NDPs. Nearly two-thirds of the men in these companies were wounded by enemy action during their 1-year tours. In a single, 75-day operation, almost 50 percent of one land-clearing unit was wounded. Other hazards included falling trees and limbs, bamboo slivers, snakes, swarms of bees, and extreme heat.

Maintenance and transportation

Maintenance problems abounded. It was common for one-half to two-thirds of the plows to suffer severe damage during an operation. Repair parts were in short supply, and frequently had to be flown in by helicopter. Heavy monsoon rains, thick dust, and constant mortar attacks on the NDPs made maintenance more than a challenge. Most maintenance was done by the company's organizational and direct-support mechanics at the cutting site or in the NDP.

Lack of transportation assets for the Rome Plows limited company mobility. Assigned ten semitrailer lowbeds, a land-clearing company could move only one-third of its plows at a time. In the Mekong Delta, where roads were impassable much of the year and the main supply routes were canals, land-clearing companies used U.S. Navy landing craft and Army M4T6 rafts to move between work sites.

Operation Cedar Falls

Almost immediately, the new units became an innovative assault tool. In the first use of land clearing as direct support of an infantry thrust, they formed the leading edge of the infantry assault in Operation Cedar Falls (January 1967). The 168th Engineer Combat Battalion, with 15 bulldozers and 2 Rome Plows, was joined in the attack by 35 bulldozers and 2 Rome Plows from the 1st, 27th, 86th, and 588th Engineer Battalions.

The operation's mission was to drive the enemy from the Iron Triangle, northwest of Saigon. Tractor teams plunged into the jungle to open a path for mounted and dismounted infantry assault forces. As dozer and infantry columns advanced, the engineers leveled enemy base camps and supply areas and established helicopter landing zones for resupply and casualty evacuation. When Cedar Falls ended, land-clearing companies had cleared 2,711 acres of jungle and had given maneuver commanders an impressive first look at the value of tactical land clearing.

Other operations in which tactical land-clearing teams were part of a maneuver assault force included Junction City (February 1967), in War Zone C, northwest of Saigon, and the Cambodian incursion in May and June 1970. In the Cambodian operation, the 62d led the way with land-clearing operations to provide access to suspected enemy base areas.

Civic action applications

Tactical land-clearing operations provided more than just a means for penetrating the jungle or for making roads and trails safe from ambush. Strip clearing along main supply routes aided villagers on their way to market by eliminating hiding places for the Viet Cong highway "tax collectors."

Besides providing security for military bases, area clearing operations opened heretofore uncultivated land. Vietnamese farmers moved onto cleared land, particularly along roadways, as soon as debris was removed. In one civic action project, the 20th Engineer Battalion cleared more than 2 square miles of forest to make way for Montagnard farmlands and homesites.

Land-clearing units operating near villages had to take care not to disrupt the lifestyle of the inhabitants. The Vietnamese hold land dear, so the U.S. Army learned to avoid unwarranted destruction of wooded areas. Units in the Mekong Delta found that the Vietnamese customarily buried their dead in the woodlines on high ground. Such locations were left undisturbed.

Tactical land-clearing operations were a valuable resource to maneuver commanders in Vietnam, and occasionally benefited the economy of South Vietnam and farmers in the countryside. Tactical planners at first believed that land-clearing operations could deny ambush sites and sanctuaries indefinitely, accomplishing what repeated infantry operations could not.

But the jungle quickly returned, and with it the enemy. A few months after operation Cedar Falls, the jungle and the Viet Cong had returned to the Iron Triangle. Within a year, the enemy used the area as its base for the 1968 TET Offensive attack on Saigon.

For further reading, see: MG Robert R. Ploger, *Vietnam Studies, US Army Engineers, 1965-1970.*

Dr. James W. Dunn is Director, History Office, Office of the Chief of Engineers. A 1957 graduate of USMA, Dr. Dunn retired from the U.S. Army as a Colonel after 27 years of service. He holds an MA in history from New York University and a PhD in American studies from the University of Hawaii. In addition to service in Europe, Vietnam, and Hawaii, Dr. Dunn has served as an instructor and assistant professor of history at the USMA, as professor and Head of the Military Science Department at St. Bonaventure University, and as Chief, Histories Division, at the U.S. Army Center for Military History.

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We the People of the United States, in order to form a more perfect union, establish justice, insure domestic tranquility, provide

for the common defense...

by Penelope Schmitt

Today, the Preamble of the Constitution reads like a catalogue of the excellent habits which our government has steadily improved through practice. Habits. But think—***perfect union*** makes your family's trip from Niagara to Yellowstone a long, unbroken road without border guards. ***Justice*** means that a random inspection stop in your home state is just to check for worn tires, not to scrutinize your identity papers. American nights are ***tranquil***—you travel in your camper, stopping at park after national park with a delicious shiver about bears—but you never worry about roaming guerillas. You calmly share the road with a convoy of National Guardsmen—in another country they might be an army of occupation, or worse, your countrymen engaged in anything BUT the *common defense*.

It might seem to you that the nightmare possibilities suggested above are purely imaginary. Perhaps you believe that when our founding fathers signed the Declaration of Independence, they merely ratified a way of life Colonial Americans had been living out since the Pilgrims set foot on Plymouth Rock. Not so.

A short tour of the Confederation in the late 1780s shows us the results of government under The Articles. Relations among the states were deteriorating into a series of trade wars. Merchants couldn't send their products across the Hudson from New Jersey to New York without paying import duties. Rhode Island was printing currency that wouldn't buy a glass of water.

Territorial contests abounded. Pennsylvania and Virginia stood nose to nose over ownership of the Pittsburgh area. Vermont blackmailed Congress into granting it statehood by leaking news of secret annexation talks with Canada. Parts of North Carolina and Tennessee seceded, temporarily forming the state of Franklin—a Balkan nation on the outposts of the frontier. So much for a perfect union.

As for justice, domestic tranquility, and the common defense, any feeble illusions the new nation might have had about itself soon shattered. The final blow came when Shays' Rebellion shook New England in early 1787. Cash-poor farmers rose against the state of Massachusetts by the thousands. When neither Congress nor the state could offer them relief, they moved to capture a federal arsenal in Springfield. The uprising was put down by a small cadre of loyal militiamen and a hastily assembled army raised by General Benjamin Lincoln, formerly of the Continental Army.

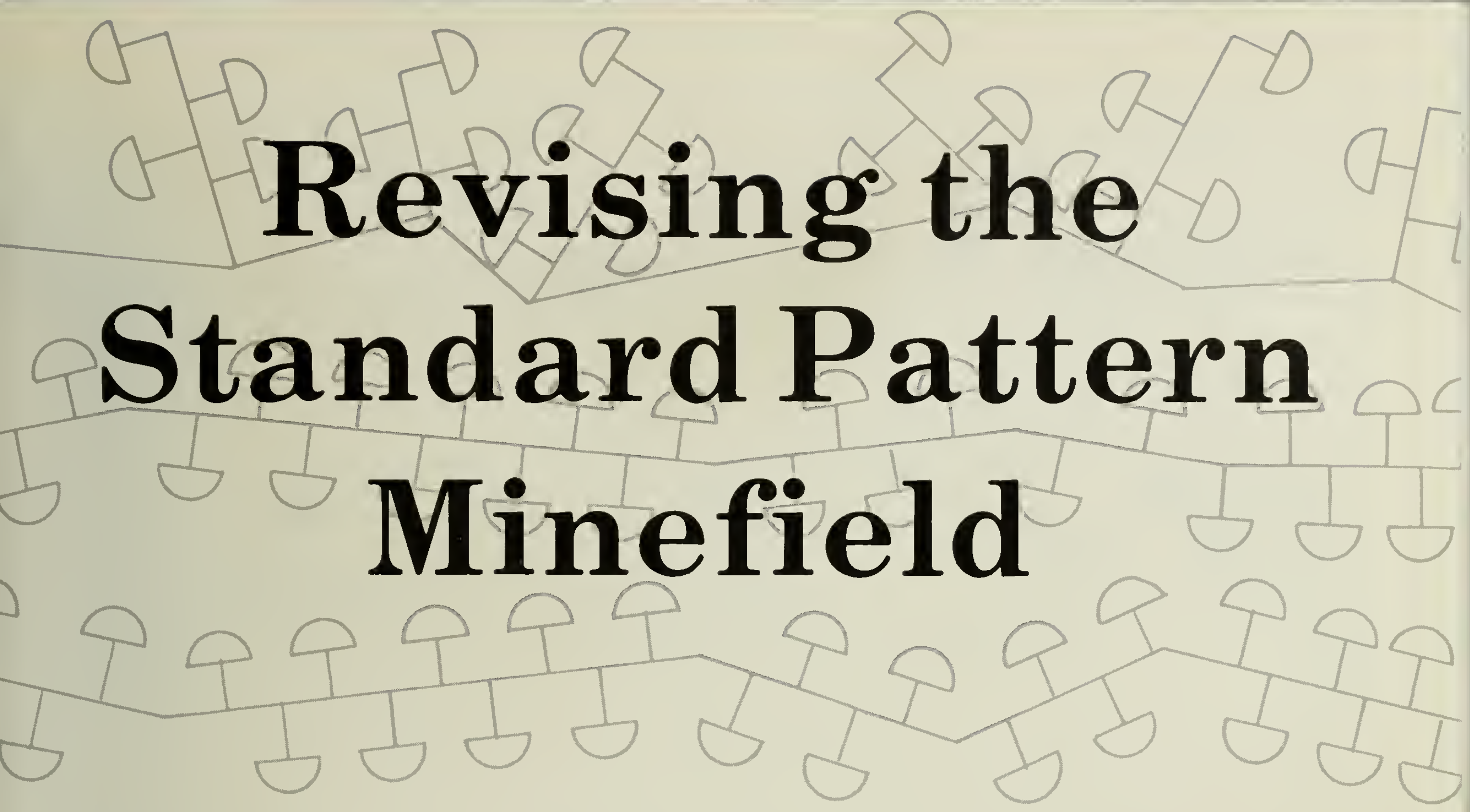
The incident riveted the determination of leaders who had been pondering the need for a new instrument of government. George Washington and others saw that a congress with no military or fiscal might was powerless to act for order or justice. "Influence," Washington said, "is no government."

In May, 1787, the Constitutional Convention met to begin writing the document which has steered our nation through 200 years of peace, war, prosperity, depression, turmoil, and tranquility.

Twenty-two of the thirty-nine men who would sign the Constitution had served in the Continental Army during the War for Independence. Their conviction of the need to provide for the common defense was founded on a solemn knowledge of the potential for violent disorder. These men, with George Washington as their preeminent leader, ensured that the Constitution was written so as to best protect the people from internal strife, as well as from external intrusion.

The military envisioned by the founding fathers was—and is—a citizen soldiery bound to serve the needs of the nation, obedient to the will of its own people. We came to enjoy perfect union, justice, and tranquility largely because military men saw our need for a common defense. We continue to enjoy those privileges because our Armed Forces still willingly defend and uphold the Constitution of the United States.

Penelope Schmitt is Features Editor for ENGINEER



Revising the Standard Pattern Minefield

by CPT Wayne Whaley

Let's not waste words. We need a standard tactical minefield that reduces time and logistics requirements. Such a minefield has been developed by the 1st Engineer Battalion (Mechanized) at Fort Riley, Kansas.

This minefield can be easily laid from an M113 armored personnel carrier (APC) or a 5-ton dump truck. It is simple to record and clear, though enemy forces find it hard to breach. Adaptable to most terrains, it accommodates both buried and surface-laid mines.

The minefield is more than 100 meters deep, and cannot be breached by standard line charges. It has three belts, and offers the option of variable density without a change in its pattern. It can serve as a building block for longer linear obstacles, and can accommodate a variety of deception patterns. Finally, it is standardized so task-organized units can work together.

Laying the minefield

After a site is selected, break the engineer platoon into teams. Each squad works as a team to lay, bury, and arm mines. The platoon leader and platoon sergeant supervise the operation, record the minefield, make progress reports, and provide local security with the M2 .50-caliber heavy machine gun on the platoon leader's APC.

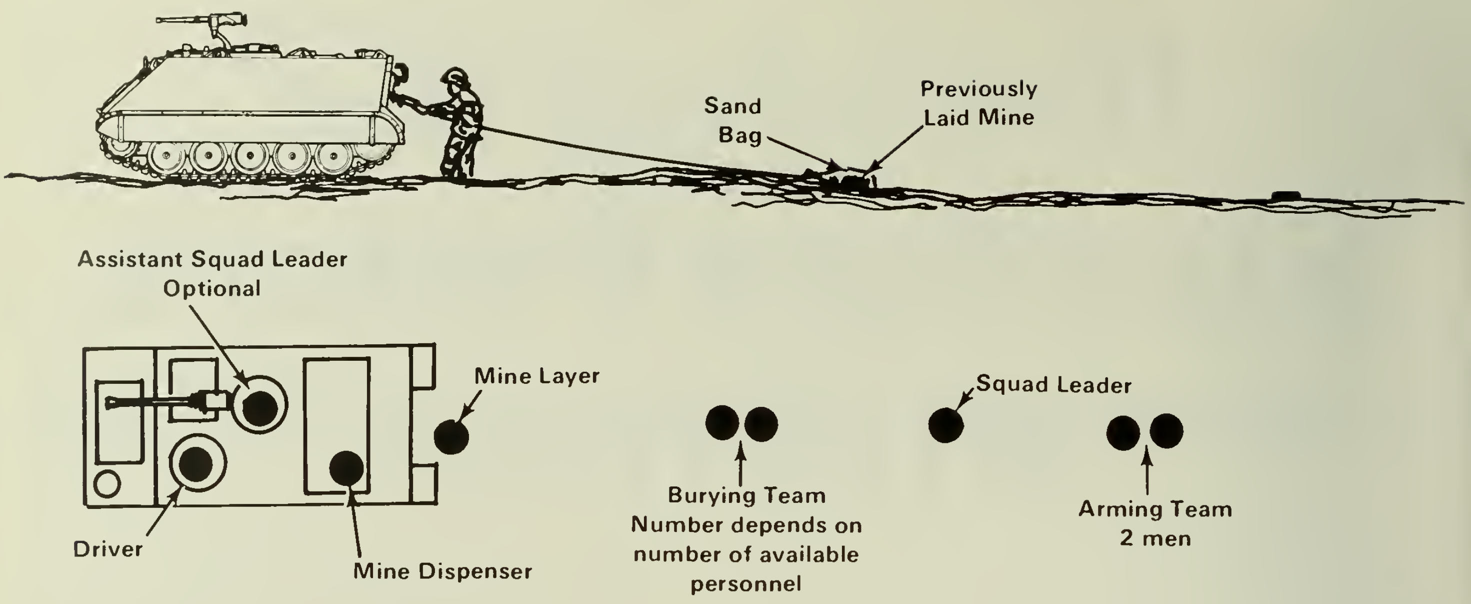
Two squads are broken into subteams as follows: an APC driver, two minelayers (one inside the APC and one outside), a burying team with enough personnel to bury mines, an arming team of two men, and the squad leader. If enough men are available, the assistant squad leader can act as the track commander, man the M2 .50-caliber, and direct the driver and laying team members.

The third squad can provide local security and supplement the working squads, or take the place of working squad members who need to rest or eat. Using the third squad this way enables the platoon to work nonstop, limited only by supplies of fuel and mines. The third squad may also make logistics runs between the work site and the ammunition supply point (ASP) or lay out another minefield under the supervision of the senior squad leader or platoon sergeant.

The direction of layout is decided upon by the OIC or NCOIC, and a base line is established at the starting side of the minefield. A rope 120 meters long, marked with engineer tape at 10, 35, 45, 55, 65, 90, 100, and 110 meters, is laid on the base line and staked down.

The minefield is constructed in three belts. The first belt has two rows; the second and third belts have four rows each. The first squad lays odd-numbered rows, the second lays the even-numbered rows. Rows are 10 meters apart; belts are 25 meters apart. The first mine of the first row of each belt is laid 10 meters from the base line. The second row begins 15 meters from the base line; the third row, 12.5 meters; and the fourth row, 17.5 meters from the base line. Other mines are laid at 10-meter intervals within rows.

To ensure the APC drives in a straight line, the squad leader chooses a landmark as an aiming point. If no landmark is available, the squad leader can erect a u-shaped picket for the driver to sight on. The distance from the base line to the landmark depends on local visibility conditions and the size of the feature. The landmark should be narrow—a building 300 meters away is not a


Sand Bag
Previously Laid Mine
Assistant Squad Leader Optional
Mine Layer
Squad Leader
Burying Team Number depends on number of available personnel
Arming Team 2 men
Driver
Mine Dispenser

Equipment and personnel positions during minelaying

good feature to choose, since a variance of 3 to 4 degrees in sightings could lead the driver to veer off course and run into a previously laid row.

To measure distances between mines, attach a rope to the rear of the APC, and tie a sandbag or other weight 10 meters down the rope. As the sandbag passes by the previously laid mine, the mine-dispensing soldier inside the APC hands another mine to the minelayer outside the APC, who can then lay the mine at a 10-meter interval. The minelayer must lay the mine to the side of the rope so that the sandbag does not drag over a previously laid mine. The soldiers proceed in this way until they reach the end of the minefield. At the end of the minefield, the squad leader directs that minelaying stop.

The APC driver moves forward another 20 to 50 meters before returning to the base line to begin another row. He disguises the end of the minefield by varying the location at which he makes his turn. As in all minefields, rows are laid from the enemy side toward the friendly side.

Up to 40 mines may be stored in the APC. After returning to the base line, the squad removes packing material and reloads the APC with mines. A well-trained unit can move with an APC at a speed of between 2 and 4 miles per hour. The platoon can emplace about 200 meters of minefield front per hour, depending on conditions.

The burying team follows the laying team. They dig holes for mines and put the soil in sandbags, to be removed after minelaying is done. Depending on vegetation or snow cover, 10 to 30 percent of the mines are buried. To avoid a pattern of burying every other or third mine, the squad leader decides how many mines per row will be buried, and designates an appropriate number of holes in random sequence.

The arming team arms the mines and installs tilt rods and antihandling devices. They then emplace and camouflage the mines. The squad leader directs the arming team to install antihandling devices in random sequence to avoid creating a detectable pattern. He must let the platoon leader know which mines in the row are buried or equipped with antihandling devices for recording purposes.

Recording procedures

The recording team (platoon leader or platoon sergeant) records the minefield on DA Form 1355, *Minefield Record*. The diagram showing the minefield layout can be preprinted. Mines that are buried and/or have antihandling devices are noted. Since each row holds the same number of mines, the platoon leader need only keep track of which rows are completed to report the percent of minefield complete. Since minefield recording is simplified, the platoon leader and platoon sergeant can spend more time supervising their platoon, and less doing paperwork.

Variations

The minefield can be modified to include turning points, antipersonnel (AP) mines, different densities, and irregular inner rows (IIR), as desired. To include turning points, all rows must turn in the same direction at once, at the same point, and proceed in the same direction for the same distance. If AP mines are to be added, they are emplaced as in the current standard pattern minefield to form clusters. If clusters are added to the minefield, the distance between rows should increase by 10 to 15 meters.

To alter the density of the minefield, the distance between belts should be increased from 25 to 50 meters, or the third belt should be eliminated. The field's density can be decreased where the harassment or protection of unlikely enemy avenues of approach is intended. Adding mines in an irregular pattern between belts may confuse the enemy. Mines can also be added to the leading edge of the minefield, as in an IIR. This creates an irregular outer edge (IOE). The IIR or IOE should be laid by hand after the minefield is complete. It need not follow any pattern, as long as it is accurately recorded on DA Form 1355. Adding an IOE or IIR slows down the clearing and recovery of the minefield by friendly units.

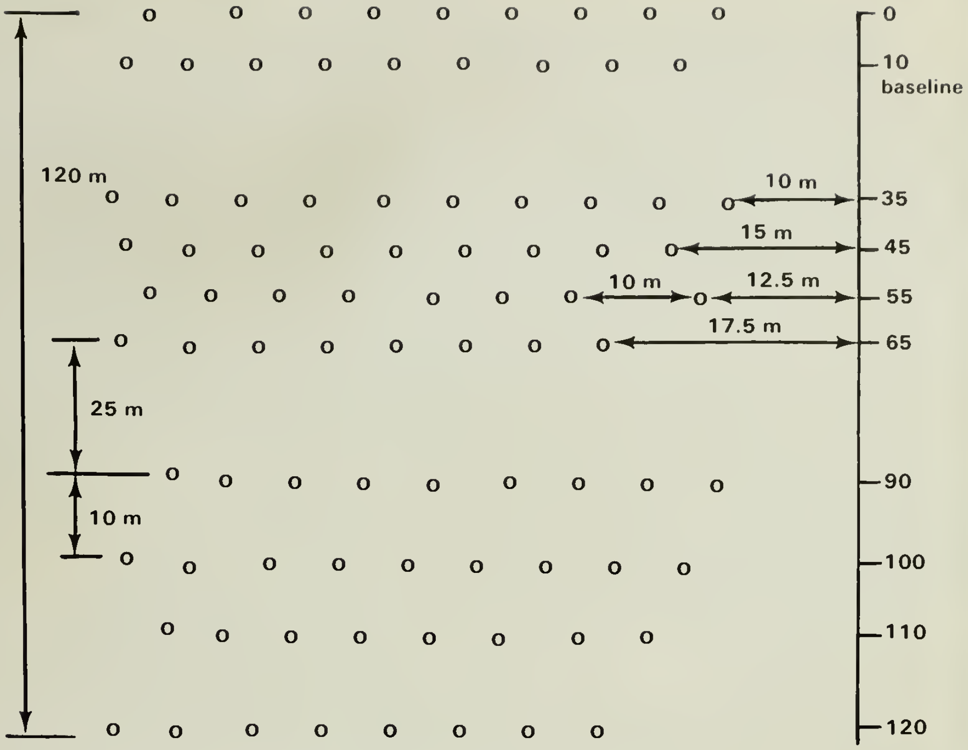
Field experience

The 1st Engineer Battalion minefield has been successfully employed in the field, including at the National Training Center. Several engineer units that have evaluated ARTEPS or have been trained with or evaluated by the 1st Engineer Battalion have decided to adapt this minefield in various degrees into their SOPs. These include the 4th ENG BN at Fort Carson, CO; the 8th and 17th ENG BNs at Fort Hood, TX; the 7th ENG BN at Fort Polk, LA; and the 10th ENG BN in Germany, all of whom are now using this minefield.

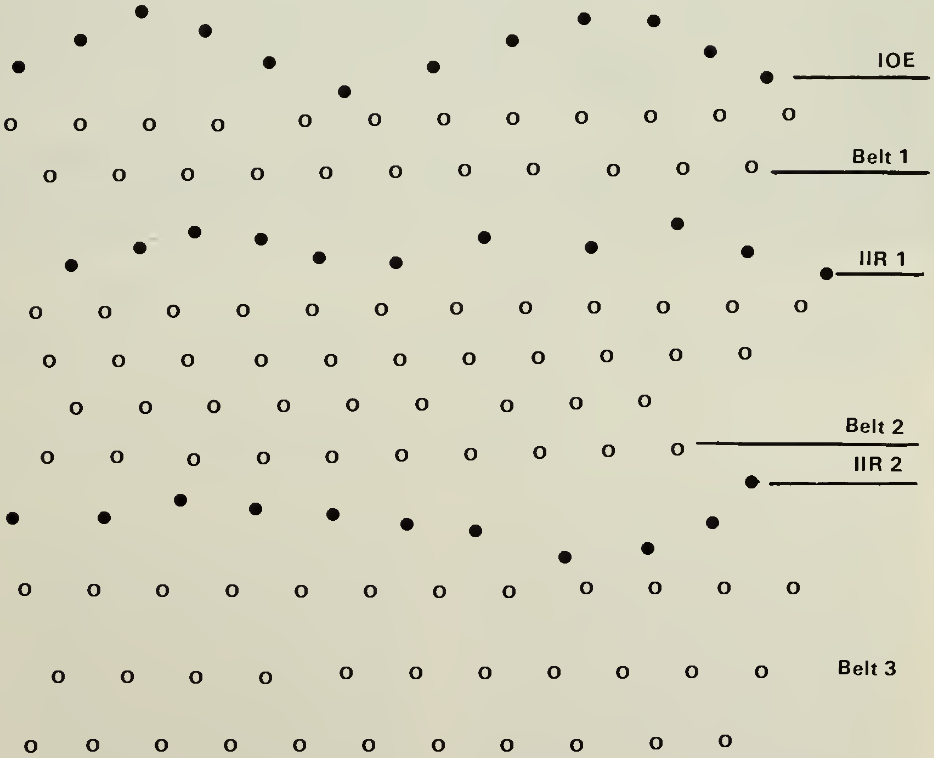
The minefield can be used by both wheeled and mechanized units, although it is more suited to mechanized units, which have better cross-country mobility. It can be emplaced quickly and can be used by engineer units on the move to enhance flank protection.

On the AirLand Battlefield, where speed and time are critical, the 1st Engineer Battalion minefield is superior. The Army should adopt it—now.

CPT Wayne Whaley is currently serving with the 82d Engineer Battalion in West Germany; he has also served with the 1st Engineer Battalion at Fort Riley, Kansas. CPT Whaley holds a BS in architectural engineering from Kansas State University, and is a graduate of EOBC and EOAC.



Configuration of revised standard pattern minefield



Minefield with irregular inner and outer rows

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Space: The new high ground for engineers

by MAJ Thomas C. Suermann

The Army is rapidly expanding its horizons from terrestrial operations to space-based solutions for strategic, operational, and tactical missions. This commitment to space is not new, but renewed—the Army has been active in space programs since the Redstone rocket was developed. America's first satellite, the Explorer I, was built by an Army team and launched aboard a four-stage, modified Army rocket, the Juno.

When the National Aeronautics and Space Administration (NASA) was created in 1958, it acquired the Army's launch vehicle program and the Jet Propulsion Laboratory in Pasadena. As a result of this and other program transfers, the Army's leadership role in space programs soon diminished to ballistic missile defense proponency. The Army became a user of systems developed and controlled by other services.

Recent initiatives

In the mid-1970s, the Army began to reverse this trend by taking the lead in the Tactical Exploitation of National Capabilities Program (TENCAP). This program provides national level systems support to battlefield commanders.

In 1983, the Army took further steps to shape its future in space. In quick succession, the Army formed the Army Space Council, the Army Space Working Group, and the Army Space Office. In 1984 the Army Staff Field Element was created at the U.S. Air Force Space Command. Then in September 1985, this organization became the Army Space Planning Group (ASPG), serving as the Army element in the new unified U.S. Space Command (USSPACECOM).

In July 1986, the U.S. Army Space Institute (USASI) was established at Fort Leavenworth as TRADOC's

Space construction may become an Army engineer task on such sites as this conceptual "lunar colony."

focal point for space training and doctrine development. In August 1986, the U.S. Army Space Agency (USASA) was provisionally activated in Colorado Springs as the Army element of USSPACECOM.

The USASA will provide the Army's perspective on planning for DOD space systems support to land forces and strategic defense. The Agency will integrate Army needs into USSPACECOM planning and operations and—in the future—will provide operational forces for Army space missions.

Current initiatives in the Army Space community include development of an Army Space Master Plan. This plan is the blueprint for Army exploitation of space. It is also the basis for efforts which will support programs such as the Strategic Defense Initiative (SDI), the Air Defense Initiative (ADI), and the theater missile warning and defense system.

Engineers in space

Opportunities for Army engineers are expanding with the Army's growing participation in space programs. The Army's NASA detachment, which is under the supervision of the new Space Agency, already has engineer officers on board at the Johnson Space Center in Houston. They are carrying out valuable geological analysis and space system experimentation. As the Army refines its space operations, demand for topographers, geologists, and structural engineers will increase. The Army will also need more mission specialists familiar with satellite operations and the orbital parameters that affect their specialties.

> ***"Future Army operational doctrine must capitalize on emerging space capabilities."***
>
> *ARMY SPACE POLICY*

The Army and Air Staffs have recently approved assignment of an operational Army detachment to the Consolidated Space Operations Center (CSOC) at Falcon Air Force Station near Colorado Springs. This detachment will operate and manage satellite constellations. Army engineers are likely to be included, but they must begin planning and training for their specialized missions immediately.

Engineer space projects cover a full spectrum of disciplines, including extraterrestrial terrain analysis, digital imagery target recognition, and synthetic aperture radar (SAR) data exploitation. As artificial intelligence (AI) and robotics applications increase, so will the need for engineers who can effectively manage space systems and issue commands to orbital platforms that are capable of increasing the effectiveness of ground forces.

Army space engineers must be prepared to use the NAVSTAR Global Positioning System (GPS), a satellite system that pinpoints location and tracks speed of vehicles, aircraft, and individual soldiers far more accurately than present means.

(continued on page 43)

Trends in Engineer Officer Training

by MAJ Edward Hayes and Penelope Schmitt

The Engineer Officer Basic and Advanced Courses (EOBC and EOAC) have been evolving towards a new format since 1985. Let's look at the program that is shaping the future of the Corps—How do the courses of 1987 differ from the old curriculum? In what roles can we expect graduating officers to be strongest? How can graduates of the new curriculum expect their careers to develop? What can they do to determine the direction of their own career paths?

A changed curriculum

The redesigned curriculum for the EOBC and EOAC courses has intensified training for the combat missions of the Army Engineer. The goal is clear: Make engineers vital players on the combined arms team. Missions primary to AirLand Battle doctrine—mobility, countermobility, and survivability—are also primary in the classroom. Young officers learn to manage the engineer mission interface with other branches of the Army in low-, medium-, and high-intensity conflicts.

The EOBC/EOAC curriculum has been streamlined to eliminate duplication of effort in the two courses. EOAC will no longer repeat material taught in EOBC. Course designers have also excised intensive training in some technical engineering tasks, especially in heavy construction and other general engineering areas. Less time is spent in learning how to lay pipeline, analyze soils, and design drainage. Materials on concrete production and construction management have been reduced by half from the former curriculum.

Reshaping the engineer officer corps

Such changes in the structure of engineer officer training are intended to produce a reshaped officer corps. Let's look at the intentions, and at the near term results.

The Engineer School aims to produce officers who think clearly and solve problems readily in a wide variety of environments. To this end, the technical side of military engineering has been brought into better balance with the needs of a modern army—our engineers can no longer be walking repositories of all the engineering tasks. There's just too much to know. Instead, officers must learn to access, manage, and employ information and resources effectively.

Here's what the changes in curriculum have meant in the EOBC and EOAC courses:

In the EOAC course, however, technical instruction has been cut by 126 hours. This change reflects a conscious effort to excise technical material unneeded by engineers in wartime conditions. Theater of operations construction standards are stressed. Less time is spent on engineering theory and design, and more time on the procedures to adapt to sites and construct from existing designs such as those found in the Army Facilities Components System (TM 5-300 series).

Trends in Engineer Officer Instruction, 1979-1987

	EOBC COURSE				EOAC COURSE			
Content	FY 79 hours	%	FY 87 hours	%	FY 80 hours	%	FY 86 hours	%
Technical*	151	26	159	20	348	33	222	20
Nontechnical**	420	74	656	80	1040	67	1093	80
Total	571		815		1388		1315	

*Technical instruction includes structures and utilities, roads and airfields, and nonstandard fixed bridging.

** Nontechnical instruction covers combat survival skills, logistics, leadership, administration and training, and mobility, countermobility, and survivability missions.

Technical instruction as a proportion of course content has fallen from about a quarter in EOBC and a third in EOAC, to a fifth of the instructional time in both courses. The actual amount of technical instruction has changed very little in EOBC. The main change is that officers in EOBC now receive over 200 hours *more* instruction in the nontechnical areas than in the old EOBC course. This new emphasis on combat missions, logistics, leadership, and management skills is creating junior officers who are better prepared for combat missions, yet still competent in the required military engineering skills.

The goal of the EOAC course is to give officers the informational tools to execute combat-critical engineering missions, general engineering missions in the theater of operations (see FM 5-104, *General Engineering*), and the management and leadership skills to solve problems collectively.

In reducing technical instruction, the Army Engineer School has not abandoned high standards—it has recognized that educating experts in an age of rapidly expanding knowledge is a job for universities and technical institutions. (For example, see special training programs described in "Space: the New High Ground for Engineers," p. 40.)

There is room for both specialists and generalists in today's Engineer Corps. In FY 1979, almost half the students in EOBC held a degree in engineering. By FY 1986, only 26 percent had an engineering degree. The number of students with degrees unrelated to engineering (liberal arts, psychology, business, and the like) rose from 23 percent to 39 percent. Although the number of students in EOBC who have no degree has risen from 10 to 14 percent, it remains low.

In EOAC, very few students hold no degree—only 7 percent. Among the others, the proportion of degreed engineers is greater than in EOBC—40 percent. Another 22 percent hold engineering-related degrees in physics, math, geology, biology or chemistry. The remaining 38 percent hold degrees in other areas. Ten percent of each class hold MA or MS degrees. Though advanced technical expertise is by no means a prerequisite for success as an engineer officer, EOAC graduates remain a more technically oriented group than the typical EOBC class.

After EOAC—choosing your path

How will the changes in the curriculum affect the military careers of engineer officers? Those who seek careers in troop leadership, staff positions, or in combat engineering will find that EOBC and EOAC dovetail perfectly with their training needs. The EOBC course is a better school for leadership than ever, and EOAC has been redesigned to focus more precisely on solving military engineer problems in the theater of operations.

Engineer officers who plan to specialize in technical areas should seek additional training on their own. Options include professional engineer certification (see ENGINEER, Fall/Winter 1986, pp. 41-42), enrollment in advanced degree programs or locally available seminars and classes, and active membership in professional societies. Regardless of their area of expertise, officers should maintain active reading programs to stay informed of developments in their fields.

Whatever their career goals, graduates of the redesigned engineer officer training program at the U.S. Army Engineer School are better equipped to manage information, to execute combat engineering missions, and to lead effectively in today's Army of excellence.

MAJ Edward Hayes is currently Chief, Structures and Utilities Branch, Department of Military Engineering, U.S. Army Engineer School. He holds a BS from Norwich University, an MS in civil engineering from Purdue, and an MS in systems management from USC; he is also a CGSC graduate. MAJ Hayes has served with the 23d Engineer Battalion in West Germany and the 52d Engineer Battalion at Ft. Carson, Colorado. He has also served as project engineer and Air Force liaison officer for the Europe Division, Corps of Engineers.

Penelope Schmitt is Features Editor for ENGINEER.

Space (continued from page 41)

NAVSTAR will let combat forces record minefields and locate enemy obstacles while performing mobility and countermobility missions in support of tactical commanders.

Space engineers must also be familiar with designing and erecting large space structures capable of satisfying on-orbit logistic functions in support of AirLand Battle doctrine. There are many hurdles to be overcome before such engineering challenges can be met. The Corps, true to its motto, "Essayons," has already begun to explore solutions. The Construction Engineering Research Laboratory (CERL) at Champaign, IL, and the Engineer Topographic Laboratories (ETL) at Fort Belvoir, VA, are exploring ideas that will allow the Army to use space to improve support to ground forces.

Building for the future

As the Space Institute develops its training base requirements and the Space Agency develops operational support planning for Army field forces, personnel managers will be searching their files for qualified people to lead the Army in space. The U.S. Air Force already administers an Undergraduate Space Training (UST) program. Although the Army will use UST as part of a joint training effort, it will still have to develop a program particularly suited to its own needs.

Several civilian and military schools help Army engineers to bridge the professional space education gap. Excellent graduate programs at the Universities of California, Colorado, and Illinois, at Stanford, Texas A&M, Georgia Tech, the Naval Postgraduate School, and the Air Force Institute of Technology are preparing engineers to confront new challenges in space.

The leadership challenge

Our sister services and several hundred defense industries have already begun expanding into space. The Army—particularly the Corps of Engineers—must plan for the future in space now. Army engineers have always been proud to be the "first in and the last out." We have consistently and valiantly helped to secure the high ground.

Space is our new high ground. Destiny beckons us.

MAJ Thomas C. Suermann is a staff officer with the Space Plans and Policy Division, U.S. Army Space Agency. He has served with engineer units in the 82d Airborne Division and in Germany. He has also served as a command engineer in Korea and as an instructor at West Point. Most recently, he was Brigade Operations Officer for HQ Command, XVIII Airborne Corps, during operation Urgent Fury in Grenada; he was also Chief of Operations in the Corps Engineer Section. He holds an MSE in Aeronautical Engineering from Princeton University, and is a 1971 USMA graduate, a graduate of CGSC, and is a registered professional engineer in Virginia.

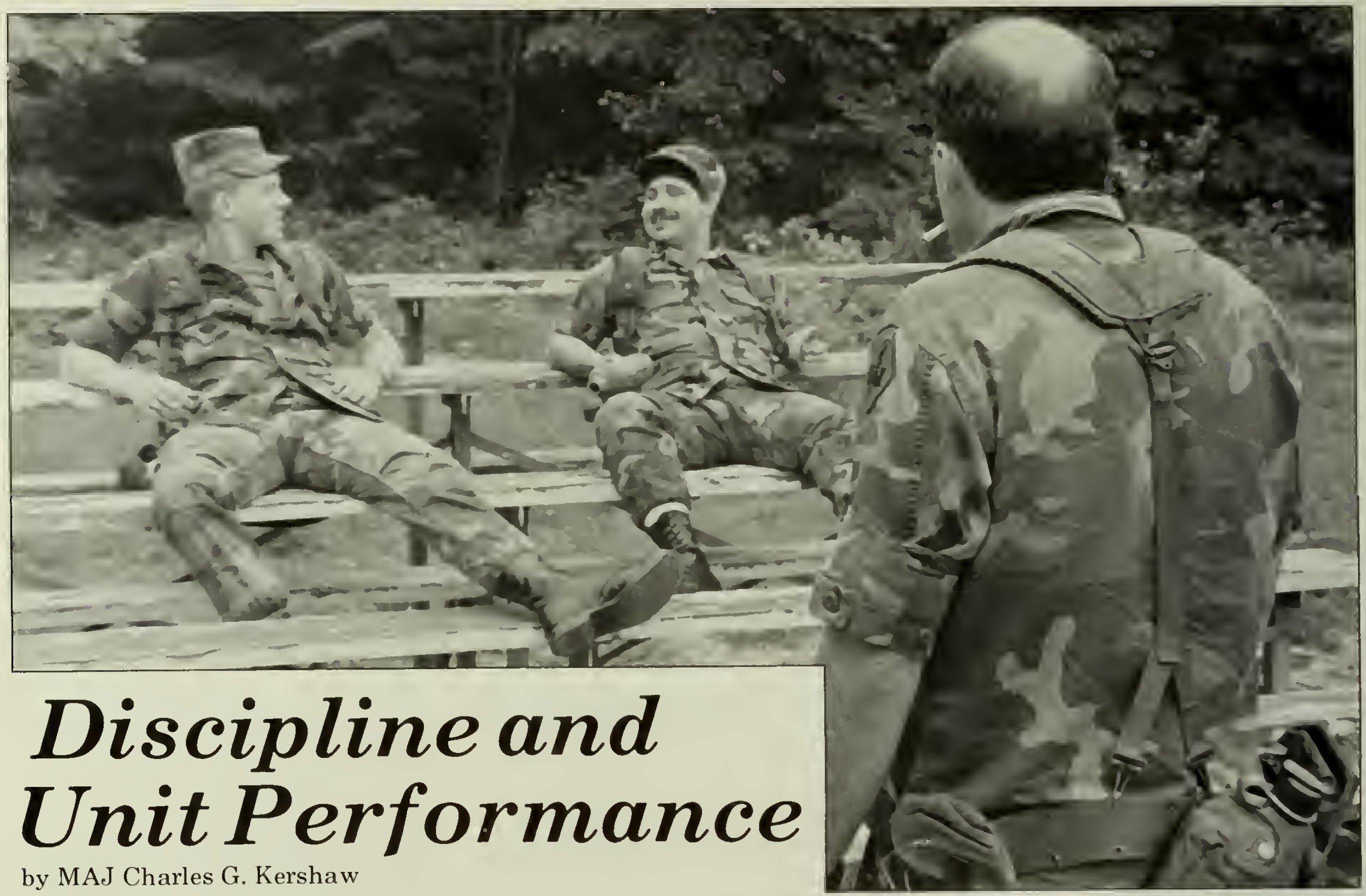


Photo by PFC Richard M. Sanborn

Discipline and Unit Performance

by MAJ Charles G. Kershaw

Soon after I arrived at my new duty station, I donned my load-carrying equipment (LCE), and headed to the range to requalify with my individual weapon.

At the range, soldiers stood in concrete foxholes, zeroing their weapons. The range NCOIC and two other safety NCOs walked the firing line while small groups of officers, NCOs, and soldiers milled in the background, waiting their turns to fire.

The safety NCOs wore their LCE hanging open and loose as they pried pebbles from the ground with M-16 cleaning rods. A bareheaded master sergeant, whose LCE also draped open, briefed second firing order, as they lounged on the bleachers. Others around me, including a young captain, had not fastened their equipment.

I asked several individuals what the unit policy was regarding wear of the LCE. The captain said he wore his open because everyone else did. The master sergeant grudgingly responded, "Sir, if that's what you want, I'll fasten it."

The sergeant's exasperated reply to my queries bothered me. I expect to see soldiers wearing their uniforms smartly, even in the field. Precision in training fosters success in combat. Soldiers become accustomed to working in an environment of excellence characterized by pride, discipline, and attention to detail.

Military leaders judge units by how well they execute the small details of tactics, gunnery, maintenance, and appearance. In other words, they look at the basics.

According to a study conducted at the Naval Post Graduate School entitled "Excellence in Combat Arms," senior commanders commented that they could not tell if a unit was excellent in just a few minutes, but they could usually determine whether it was good or not. Appearance ranked high as an indicator of discipline.

The Army rests on the foundation of discipline. Units cannot and will not accomplish their missions without it. Discipline trains soldiers to react properly in the absence of leaders and orders. It enforces adherence to unpopular decisions. Tough, demanding tasks become easier to accomplish. Discipline prepares soldiers to endure the confusion and stress of combat.

What disturbed me most about the scene at the zero range was the sloppiness of NCOs and officers charged with responsibility for enforcing policies and standards. Leaders establish standards of performance by what they do, not by what they say. I felt that the standard being set by their example undermined the fabric of unit discipline.

Ardant du Picq wrote that time—a long time—is needed to give leaders the habit of command and confidence in their own authority and to give soldiers confidence in their leaders and in their fellows.

It is not enough to order discipline. The chain of command must continually practice it.

MAJ Charles Kershaw, formerly an instructor in the Command and Leadership Branch, Department of Combined Arms, USAES, is now the brigade S4 of the 193d Infantry Brigade in Panama.

Past in Review

Land Clearing in Vietnam

by CPT Rodney R. Gettig and Dr. James W. Dunn

The Vietnam Conflict only recently became history, yet techniques learned in the rice paddies and jungles are already being forgotten. Hidden in old field manuals and reports, valuable lessons are in danger of gathering dust on back shelves.

The current situation in Central America, U.S. Army contributions to training friendly armies, and our need to be ready to operate in a jungle environment should prevent us from putting these lessons in the archives too soon.

One important engineer story that deserves to be returned to the light is our experience with tactical land-clearing operations in Vietnam from 1966 to 1971.

A key mission in jungle operations

The Army turned to land clearing to deny cover to the Viet Cong and the North Vietnamese Army, who concealed base camps, infiltration routes, and sanctuaries in jungle vegetation. We also needed to combat the jungle itself—modern tools of war can't move through dense rain forest. Eventually, land clearing became the key to mobility and success in many American offensive operations.

We create the Rome Plow

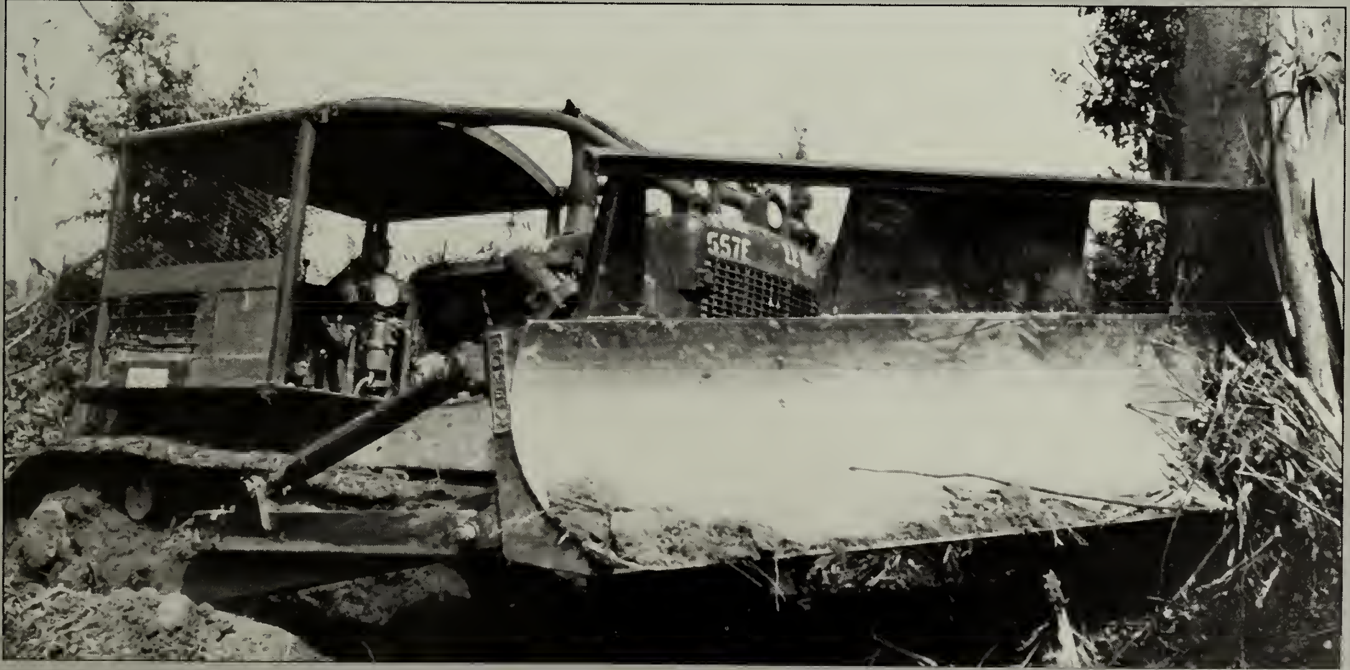
In November 1965, General Westmoreland dispatched an engineer officer to Australia to watch bulldozers towing heavy steel balls and ship anchor chains through the jungle. The officer actually brought a lost art home—our engineers taught the Australians how to do this early in World War II. The dozers proved able to clear trees less than 10 inches in diameter.

The Army also tested a dinosaur called the Transphibian Tactical Tree Crusher, which floated over swampy jungle floor and could fell trees up to 6 feet in diameter. Unfortunately, it was vulnerable to enemy fire, and its complex hydraulic system often broke down.

While the specially-designed Transphibian proved unreliable, a simpler system using a sharpened bulldozer blade realized great success. The blade, made by the Rome Construction Company of Rome, Georgia, was originally designed to clear American farmland. The Army tested four blades with accessories, including a gasoline-powered blade sharpener, in August 1966.

The Army installed the Rome blade on medium tractors, usually the D7E or HD-16M, and added a steel cab to protect operators from

(continued on page 34)



The Rome Plow rapidly became the Army's workhorse for land clearing in Vietnam.

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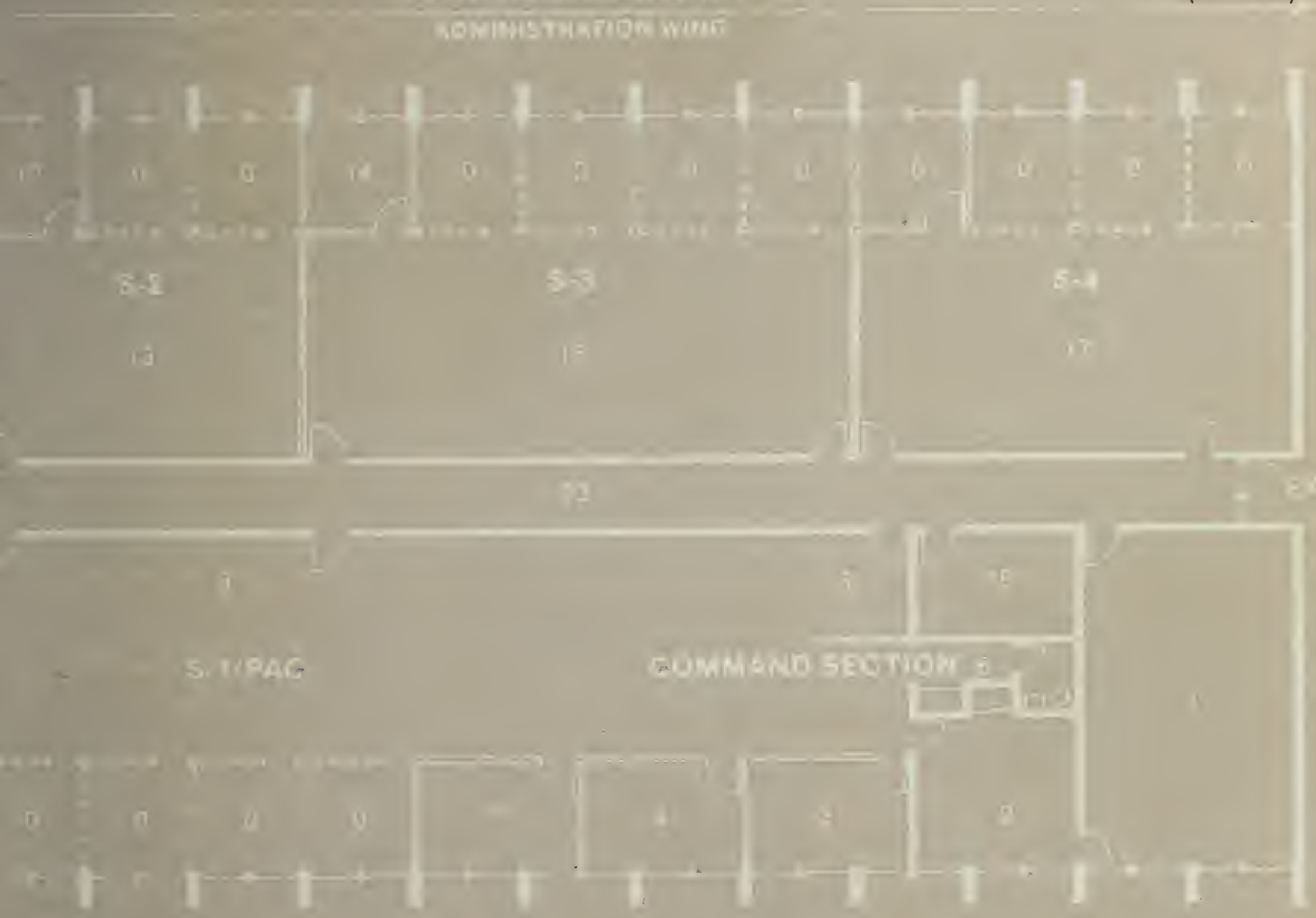

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The DEH and Commercial Activities—a Perspective

by Stanford C. Draper

I've spent most of my 30 years of federal service in the facilities engineering business—first as an engineer officer, then as a civil servant. In all that time, nothing has affected Directors of Engineering and Housing (DEHs) so dramatically as the commercial activities program.

Commercial activities (CA) are services and products available from private sources that the government could obtain by contract instead of using federal employees.

Since 1979, 40 DEHs in the United States have undergone CA package reviews to see whether real property maintenance activities (RPMA) carried out by their staffs could be obtained more economically by contract. As of the end of FY 87, CA reviews had resulted in 18 in-house decisions and 22 contracts.

More than half of all installation RPMA is now accomplished by contracts that cover functions such as custodial services, refuse collection, pest control, utilities operations, and building and grounds maintenance and repairs.

The effectiveness of the commercial activities program is widely debated.

On the one hand, most DEHs are looking for ways to improve cost effectiveness, productivity, and customer satisfaction. Contracting out offers opportunities to concentrate the DEH's limited staff resources on increasingly complex management responsibilities rather than day-today operations.

On the other, many doubt whether the contracts have really saved the government money. Those doubts are reinforced by analyses that have shown prices escalating tremendously at several installations compared with the bids that initially led to the contract decision.

Regardless of the pros or cons, the DEH is confronted with a disturbing reality whenever a commercial activities study is undertaken. Whether the result is an in-house win or a contract decision, these studies prove traumatic, morale-destroying, and disruptive to operations.

I've asked myself many times, "How did we let this program impact us so negatively? How can it serve the installation better?"

Then I remember my first encounter with commercial activities. No doubt, the problems start when engineers fail to take the bull by the horns.

I still remember the call I received from the comptroller back in 1973 when I was still in the active Army and the post facilities engineer. He informed me I was required to examine my operation to determine how it could be made more efficient and less costly to operate. Furthermore, I was supposed to develop a specification that could be used to solicit a contract for the work.

I told him he was "nuts" . . . that I had neither the resources nor the inclination to do it. He quoted the regulation and eventually sent me a copy. I did nothing.

Later, I learned he had responded to the regulatory requirement by stating there was no interest in contract accomplishment of the work. That answer was accepted all the way up to HQDA.

My first lesson learned on commercial activities was, "Ignore it. Someone else will handle it."

Unfortunately there was little, if any, guidance to the contrary from the engineer side of the house. I've come to believe that because of our abstinence during those early years, others gained more clout in running the program.

Commercial activities program managers still tend to see DEHs as reluctant participants whose information must be viewed with skepticism. We must become leaders rather than followers in these studies.

This isn't easy. Aside from dealing with credibility problems, a commercial activities study amounts to a full time job for several managers. But the work must be done as an extra duty by an already overburdened DEH staff without disrupting customer service.

I find it miraculous that any DEH can manage 50 percent of the base operations budget, effectively obligate those funds, and simultaneously prepare an adequate contract solicitation package. Only those who have personally experienced a study from start to finish and lived with its outcome can truly appreciate the magnitude of the accomplishment. The problems encountered by installations are not fully understood at higher levels and are often handled naively.

Still, I firmly believe we can make this program produce positive results for the DEH family. Exerting leadership is the key.

Most study inadequacies result because those who have taken charge misunderstand or underestimate the complexity of DEH activities. All DEHs who are slated for CA reviews should seek out the installation's CA program manager and contracting officer early to establish a rapport. If they can get their installation commanders to give them the lead action on the study, all the better.

The goal must be responsive, cost-effective customer support . . . regardless of whether the work is ultimately handled in-house or by contract. DEH managers should heed the fact that if the DEH goes contract, they will retain their operational responsibilities and also be required to administer the contract.

DEH managers must ensure the contract solicitation is one they are prepared to administer. The com-

(Continued on page 12)

Engineer

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About the cover

This issue's cover shows the Army's standard architectural design for a Battalion Headquarters with classrooms.

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CLEAR THE WAY

by MG William Henry Reno, Commandant, U.S. Army Engineer School

This issue of ENGINEER is devoted to one of the Corps' most important and challenging engineer assignments—The Director of Engineering and Housing.

Many would say, and I agree, the DEH is the most important position on the installation staff. He has stewardship over all of the installation's facilities, utilities, natural resources, and family housing. He spends over half of the installation's base operations budget. If you read the "Dial the Commanding General" column of any post newspaper, you know a week doesn't go by without questions about repairs or maintenance or roads or pests . . . problems that need care from the facilities engineers.

The DEH is the lifeblood of installation management and represents the enduring values of excellent facilities and support that Army families carry from assignment to assignment. No one on the commander's top team more directly affects the living and working conditions of soldiers and their families. The number and quality of buildings and the dependability of maintenance and repair equate directly to quality of life.

Commanders and customers expect a DEH to be responsive and cost effective. Congress and taxpayers expect economy. How does the DEH win in an era of fierce competition for defense dollars?

He must view his business from a resource management perspective. At a time when the Army prioritizes systems acquisition by families of systems, the DEH must push for complimentary families of facilities. Only systems supported with adequate facilities will realize their potential.

The DEH must have a vision of the installation ten to twenty years out. He needs a strategy for getting there . . . a plan that is about the future, not about what he is doing tomorrow.

When the commanding general and the corporate leadership of the installation put their feet up on the table and talk to the future, the DEHs and resource managers need to be there. Unfortunately, they are usually not. They find themselves in the position of a G-4, planning how to support the attack after the troops have crossed the line of departure.

Every DEH should check his commander's calendar, circle every meeting that deals with the future of the installation, and invite himself to attend. He has got to make himself part of the corporate infrastructure and convince his commander to strike a balance between BASOPS and mission. Otherwise, the commander and DEH will find themselves presiding together over a poorly configured and deteriorating installation. Such is the case in an era of declining resources, when priority tends to go to the mission at the expense of BASOPS.

To fulfill their responsibility as stewards of resources, DEHs must strive to think and plan as if they were running their organization for a profit.

They must exercise the three principles of—

- Sound Stewardship: Grades, skills and operational standards must be responsive to installation requirements—not inflated—but meeting requirements in the model of an efficient contractor.
- Corporate Strategy: A viable concept of operation and a vision of the future must govern facilities management.
- Team Effort: Quality circles and other innovative management techniques must be applied to achieve an efficient organization and build a proactive team spirit.

A move towards contracting out is with us. As stewards of resources, the DEHs are challenged to seek a mix of contract and in-house operations that preserve a strong, responsive base of professional engineering expertise on the commander's staff.

Whether work is done in house or by contract, winning in the commercial activities arena revolves around customer satisfaction.

Many talented Corps of Engineers officers are now leaders in the DEH business. They must take responsibility for resource management and have the courage to streamline their organizations. It's the DEH's responsibility to put his installation in a winning posture.

Our civilian team members are as important as the military—and as professional, as dedicated, as competent. We must retain this outstanding work force by retaining contracts in house.

The DEH plays a key role in setting and maintaining a high operating standard for quality of life—a standard that contributes directly to a strong Army's sense of esprit and pride.

BRIDGE THE GAP

by CSM Matthew Lee, Jr., U.S. Army Engineer School

"We are all born to be heroes . . . ." The words belong to an American philosopher named William James. The attitude can belong to anyone who decides to own it. James also said, "We commonly lead lives inferior to ourselves." So which is it going to be for you—becoming what you were born to be, or continuing to be less than you are?

A lot of you out there may think courage and heroic acts are too much a matter of circumstance—and this is peacetime, or you sit at a desk, or you don't find heroes on ordinary work sites.

The fact is, you do. The time for moral courage is always NOW. The time for physical courage could be a heartbeat away. Sometimes when we least expect the test, we get it.

A moment like that passed me by a few years ago. I was in Korea, working with a dozen U.S. Army divers to train our Korean counterparts. The river's surface current was swift—by swift, I mean it yanked our guide rope downstream in spite of an 80-pound anchor; only our added body weight took the rope down to the 90-foot depth we aimed for. In turn, each American diver took his Korean trainee on the white-knuckle journey down into that churning, icy water.

Afterwards, feeling our courage had been well tested, we relaxed on the boat, feet dangling in the water. We still wore weights around our chests, but we had shed our tanks and pulled our masks down around our necks.

A little laughter started up, a little horseplay—and suddenly a man was in the water. I watched the river snatch him 100 yards downstream, and saw the Junior Demonstration Specialist, a guy named McNaught, fly into the river after him. Performing every rescue maneuver perfectly, he brought the man out alive.

Ever since that valiant rescue I've been wondering—why McNaught? Why not any of the other guys? Most of all, why not ME?

A lot of you are probably thinking right now that McNaught was just naturally special—born that way. You do your best, but you're no hero and no saint and have no special gift as a leader.

Consider this: maybe McNaught was born with extra-quick reflexes—but he wasn't born a skilled and confident lifesaver.

To be ready, he had to do what you, I—all of us—need to do if we are going to be the heroes of our own lives. We have to concentrate, give the utmost in attention to detail, practice, constant hard work.

This is ***moral courage***—the will to decide again and again to give the best performance, to search for good judgment, and to exercise the self-discipline of right conduct. In fact, if there had been more self-discipline that day in Korea, McNaught's heroic leap might have been unnecessary.

So yes, you can learn to become the hero of your own life. You can ***teach*** yourself devotion to duty. You can ***practice*** dedication. It's in attention to the split seconds that we make a glory of life.

So perfect your demeanor on the parade ground—have the joy of knowing precision. Think hard for what's right when you counsel a soldier—the right words could stay with him for life. Be relentless in your devotion to safety precautions on the job—eyes, arms, legs, lives depend on your will to eliminate unneeded risks.

Try doing your job today—every minute of that day—as if you were inside the skin of the most dedicated person you know. Do it again tomorrow, the next day, and the next—you could become that person, that hero you were born to be.

Engineer Update

—School News—

Directorate of Evaluation and Standardization (DOES)

New Director DOES welcomes COL George R. Kleb as its new director. COL Kleb is the former commander/director of the Water Resources Support Center, U.S. Army Corps of Engineers.

COL Kleb has served in a variety of command and staff assignments, including a company command in Germany, two tours in Vietnam, command of the 84th Engineer Battalion during the clean up of Eniwetok Atoll after the end of nuclear tests, and a variety of staff/instructor assignments at West Point and the Military District of Washington.

USAR School Affiliation Program USAR School Affiliation Program provides a link between TRADOC service schools and 91 USAR schools. Each service school is assigned four to six USAR schools based on a geographical relationship. They provide both generic and branch unique assistance to their USAR school counterparts. This program is intended to provide TRADOC and FORSCOM with a high degree of assurance that the USAR school instruction is of excellent quality and conducted by competent instructors using the best and most current instructional material.

The Engineer School is currently affiliated with the following USAR schools:

1 1155th USAR School, Edison, NJ

2 2059th USAR School, Bethlehem, PA

3 2070th USAR School, Fort Belvoir, VA

4 2071st USAR School, Owings Mills, MD

5 2072nd USAR School, Philadelphia, PA

DOES conducts bi-annual assistance visits to the USAR schools and prepares trip reports of such visits, and evaluates and reports on annual training. The directorate refers training issues to the proper agency and monitors action to resolution, providing responsive support to the USAR school system in the area of engineer proponency.

The major goal of the program is to establish the USAR schools as "satellite campuses" of the TRADOC proponent schools and thereby creating a more coherent, single system of training goals and standards for the Total Army.

Lessons Learned Bulletin The *Lessons Learned Bulletin* is used to disseminate engineer and other pertinent lessons learned to the worldwide engineer community. Lessons learned are taken from several sources, including after-action reports (AARs) from major field training exercises, combat training centers, and from field units. It is published on a quarterly basis and distributed to all Active, National Guard, and Reserve Army Engineer units, company level and above, DEHs, Engineer Districts, major commands, and others upon request. A copy of the bulletin is given to all students of the EOAC, EOBC, and ANCOC.

Field units can ensure that information in the bulletin contains valid, pertinent lessons learned by providing feedback to DOES. Units are highly encouraged to submit AARs and any other information concerning tactics, training, doctrine, equipment, and materiel. Comments and recommendations for improvement are also welcomed. All correspondence should be sent to:

Commandant
U.S. Army Engineer School
ATTN: ATZA-ES
Fort Belvoir, VA 22060-5271

Points of contact are CPT Simmerer and SFC Kovak, telephone (703) 664-4172 or AV 354-4172.

Department of Combined Arms (DCA)

TSFO Training Aid Available The latest addition to the Engineer School's arsenal of training aids is the Training Set, Fire Observation (TSFO).

The TSFO, which consists of a computer and 11 projectors, projects a terrain scene on its screen. A target appears. The student must locate the target and transmit its location in a correct artillery call for fire format. An artillery burst, replete with sound effects, appears on the screen and the student must adjust TSC burst onto the target.

Requests to use of the TSFO can be made by contacting CPT J. Nichols, (703) 664-2986 or AV 354-6004.

Department of Military Engineering (DME)

EIT/PE Exams Scheduled Engineer-in-Training (EIT) and Professional Engineer(PE) examinations will be administered by the Engineer School this fall and next spring. Dates are 16 April 1988 for the EIT exam, and 15 April 1988 for the PE exam.

Officers attending the Advanced or Basic Course on these dates should consider sitting for the exams as part of their professional development. Applications to sit for the examinations must arrive in Richmond, Virginia, at least 90 days prior to the test date. To obtain the required forms, assistance, and a brochure containing general information on PE registration, write to:

Commander
U.S. Army Engineer School and Fort Belvoir
ATTN:EIT/PE Coordinator
ATZA-TE-RA
Fort Belvoir, VA 22060

Free study guides for the exams are no longer produced or provided by the Engineer School; however, a list of commercially available texts is included in the brochure.

Materials Quality Specialist Course Moves During the second quarter of FY 88, the MOS 51G (Materials Quality Specialist) AIT Course will move from Fort Belvoir to Fort Leonard Wood. Teaching responsibilities for the course will transfer from the Roads and Airfields Branch of the Department of Military Engineering, USAES, to the 136th Engineer Brigade, U.S. Army Training Center, Engineer, FLW. The last class to be conducted at Fort Belvoir will be Class 1-88, ending in December, 1987. Class 2-88 will not be conducted in order to facilitate the physical move of property and personnel to Fort Leonard Wood. Class 3-88, will be the first class taught at Fort Leonard Wood, beginning on 8 April, 1988.

Reorganization of Technical Engineering Training Developers On 18 May 1987, the Technical Engineering Section, Army Topographic Element, DOTD, was transferred to the Roads and Airfields Branch, Combat Construction Division, DME. This transfer consolidated training development assets and responsibility for four technical engineering MOSs in a teaching department as specified by School Model '83. The four MOSs include:51G, Materials Testing; 81B, Construction Drafting; 82B, Construction Surveying; and 51T, Technical Engineering Supervisor, the capper MOS for the first three feeder MOSs. This action will result in better control and relevancy of all technical engineering subjects taught and developed by USAES and permits the Army Topographic Elements to concentrate on purely topographic tasks and subject matter.

12C20 BNCOC Moves to Fort Leonard Wood On 1 July 1987, the 12C20 BNCOC moved to Fort Leonard Wood, Missouri. This was the first course to make the move from Fort Belvoir.

Because of the decision to revise the critical task list for the MOS 12C, plans to upgrade the 12C20 BNCOC to 12C30 BNCOC have been delayed. Present plans call for the development of this course to resume in FY 88, with implementation scheduled for 1 October 1988 at Fort Leonard Wood. To cover this training shortfall, a waiver was granted to allow the 12C soldiers to attend the 12B30 BNCOC until the 12C30 BNCOC comes on line.

New POI for the 12B30 BNCOC Effective 1 June 1987, the new 12B30 BNCOC POI was implemented worldwide at ten NCO academies. The new POI is based on the 1985 Soldier Training Publication (STP). Major revisions included: increased course length from 5 to 6 weeks (attendees are MOS 12B only), calculators are required equipment, 6 tasks were revised, 6 tasks were added, and 9 tasks were deleted.

The academies validated this course in the June through September time frame. Evaluation results were consolidated at the 12B30 BNCOC In-process-review (IPR), held 15-18 September 1987, and appropriate revisions were made to the course.

Engineer School Topographic Element Reorganizes The U.S. Army Topographic Element, formerly a component of the DOTD under the Operational Control of the Defense Mapping School has been reorganized as the Division of Topography, DME, USAES. The division's mission is to serve as the USAES primary expert and principal point of contact for all proponent responsibilities related to topographic engineering and to coordinate all activities and actions with respect to topographic operation, training, and doctrine.

Responsibilites include development of doctrinal publications, field manuals (FMs); STPs; SQTs; correspondence courses; extension training products such as training extension courses, graphic training aids, and video tapes; and ARTEP products for unit training and evaluation. The new division will also teach the CMF 81 ANCOC and provide instructors to teach topographic subjects to students in USAES professional development courses. Questions or issues with respect to Army topography or photolithography may be addressed to:

Commandant
U.S. Army Engineer School
ATTN: ATZA-TE-TO
Fort Belvoir, VA 22060-5331

Engineer Update

DEH Move Effective 1 October 1987, the DEH Management Division, DME, USAES, will be transferred to the U.S. Army Engineering and Housing Support Agency (EHSC), formerly the U.S. Army Facilities Engineer Support Agency (USAFESA). The transfer came about because of the anticipated move of the Engineer School and the desire to consolidate DEH training under the course proponent, the Assistant Chief of Engineers' Office. This transfer coincides with the reorganization of USAFESA as the U.S. Army Engineer and Housing Support Center. This reorganization will not change the schedules or location of the DEH courses.

Reserve Component Advisory Staff (RCAS)

New ARNG Advisor The Army National Guard advisor to the Engineer School is LTC Richard G. Dubuque. LTC Dubuque is a member of the Rhode Island National Guard who comes to the Engineer School from Headquarters, 7th Infantry Division and Fort Ord, where he was a mobilization planner for the installation. LTC Dubuque can be reached at (703) 664-4166 or 4434 (AV 354).

Directorate of Combat Developments (DCD)

Armored Vehicles for Combat Engineers USAES is developing requirements for six new armored engineer vehicles as part of the Armored Family of Vehicles(AFV) program. The AFV is being developed to counter the future threat and to achieve significant reductions in O&S costs.

Combat engineer systems currently being considered include a squad carrier, an assault bridge, a mobility vehicle, an earthmover, an excavator, and a mine dispenser. These vehicles will allow combat engineers organic to, or in support of, heavy units to keep pace and survive with the maneuver forces. Initial fielding of the AFV is scheduled for 1995.

Soviet Threat Posters Rereleased The Engineer School's Threat Office recently updated and republished FB poster #125, "Soviet Combat Engineer Equipment—Division and Below," and FB poster #123, "Soviet Combat Engineer Tactics, Groupings, and Tech-niques."

FB Poster #124, "Soviet Combat Engineer Organizations Below Division," will be out shortly. These training aids are available from AG Publications or from the Threat Office, (703) 664-3867/3835 (AV 354-3867/3835).

Another recent publication by the Threat Office is the Periodic Intelligence Report (PERINTREP). This has been sent to all engineer battalions and contains the latest threat engineer developments. Check with S-2s to review it, since it is a classified document.

ESSAYONS—Your Ideas Put to Work In the last issue, DCD announced ESSAYONS, a new program to help get your ideas on how to improve equipment, organization, or training. Send your ideas to:

Commander
U.S. Army Engineer School
ATTN: ATZA-CDT (ESSAYONS)
Fort Belvoir, VA 22060-5281

We have received two proposals thus far. Thanks to MAJ Roger Somerville of the 177th Armored Brigade, Fort Irwin for his idea about simulating threat rollers on OPFOR tanks, and to CPT Michael Herman of 6th Army Headquarters for his suggestion about an air compressor assisted vehicle washing device. We will keep you updated regarding these and other ideas we receive.

Defense Mapping School (DMS)

DMS Courses Receive Accreditation The American Council on Education's Military Evaluations Program Division conducted an on-site evaluation in July of DMS courses for academic/college credit. Twelve DMS courses were awarded upper-division baccalaureate or graduate semester hour credits in mapping, charting, and geodesy disciplines. Academic credits for DMS courses range from vocational certification credit to graduate credit.

Accredited courses afford distinct advantages to DMS graduates who plan to continue their education either in the immediate future or later in their careers. Recommended credits per course will appear in the third supplement to the *Guide to the Evaluation of Educational Experiences in the Armed Services* (1987), and in the 1988 *Guide*. For more information, contact Dr. Linda Schultz-Shiner at (703) 664-2182, AV 354-2182, or your education center.

Engineer Update

—Career Notes—

Warrant Officers Branch

AR 611-112 Revision A total revision of AR 611-112, *Personnel Selection, Manual of Warrant Officer Occupational Specialties,* has been approved. The revision includes a new life-cycle personnel management system (Total Warrant Officer System) and guidance pertaining to utilization of a commissioned warrant officer.

Engineer warrant officer MOSs will change as indicated, although titles will remain the same:

Old MOS	**Title**	**New MOS**
310A	Utilities Maintenance Operator/Technician	210A
621A	Engineer Equipment Repair Technician	213A
811A	Photo Mapping Technician	215A
821A	Survey Technician	215B
833A	Reproduction Technician	214C
841A	Terrain Analysis Systems Technician	251D

Effective dates for the MOS change will be July through September 1988.

NCO and Enlisted Soldiers Branch

62G and 62H Overstrength Realignment MILPERCEN has identified grades E4, E5, and E6 in MOS 62G, Quarry Specialist, and 62H, Concrete and Asphalt Equipment Operator, as critically overstrength. Effective 1 August 1987, these soldiers were restricted to reenlistment retraining option F-3 and were included in the Fast Track reclassification program. The Fast Track program affords soldiers serving in overstrength skills the opportunity to voluntarily reclassify and/or reenlist for a shortage skill. If a sufficient number of soldiers do not voluntarily migrate through reclassification/reenlistment, the program provides that MILPERCEN may direct reclassification of soldiers in order to meet strength quotas.

Long-Term TDYs and Soldier Reassignment Status Commanders of engineer soldiers from CONUS-based units who participate in long-term (179 day) unaccompanied temporary duty (TDY) assignments should notify MILPERCEN so that those soldiers are not unfairly treated in follow-on assignments. For example, an NCO recently was scheduled to attend a 3-month advanced course enroute to a short tour in Korea. Unknown to the assignment manager, this NCO was returning to his home station from a 179-day TDY tour in Central America two weeks before his scheduled school date. A comment by a soldier in the NCO's servicing MILPO tipped off the schools manager to the situation and the NCO's status was adjusted to compensate for his TDY service.

—Regimental News—

Engineer Directory to be Published The Engineer Personnel Proponency Office is assembling a new Engineer Officer and Warrant Officer Directory, scheduled for publication this month. Distribution will be made to all engineer organizations of battalion size or larger. The purpose of the directory is to strengthen ties within the Corps.

CPT Glenn Tisdale is temporarily assuming the duties of regimental adjutant pending a permanent replacement. For regimental information or assistance, contact him at (703) 664-2287/3760 or AV 354-2287/3760.

Raising the Roofbeams in Europe

by COL Daniel G. Barney

More and better—these were the Army's family housing goals in Europe for almost 40 years, and the Army worked diligently to improve its housing inventory. Significant progress was made.

But in 1984, with over 70,000 government-owned, leased, and private rental units available, we could still only approve concurrent travel for about one-third of the families who came to Europe that year.

We finally realized that our nebulous "more and better" needed to be quantified. How many more homes did we need to provide? What quality standards should we meet? When could we give our service members keys to their front doors?

Since 1984, we've been striving toward a clearer goal: By 1991 we want to be able to provide a home for every family within 60 days of the soldier's arrival in Europe. This means we must have enough housing available or under construction by FY 90 to let us approve concurrent family travel for any sponsor assigned to an Army community in Europe. It's a big, complex job, and the view from midstream is an exciting mix of creative solutions to problems, lessons learned, and challenges still to be met.

Our effort to find or build homes depends on the continuous, active participation and support of the Congress, the Department of Defense, the Department of the Army, the United States Army Europe (USAREUR) and its subordinate commands, all Army communities in Europe, the Corps of Engineers, the Naval Facilities Command, and the governments of Germany, Italy, and the Netherlands. Here's what the DEHs in Europe have done to coordinate all these players and build a successful housing program.

Military families—how many?

First, they had to determine the housing needs of the forty-three Army communities in Europe. A military community is roughly equivalent to an installation in the United States, but in Europe, soldiers and facilities are not concentrated on big bases. Communities are often made up of geographically dispersed installations. Each community must provide family housing for all military personnel assigned within its geographic boundaries—including non-USAREUR Army units; Air Force, Navy, and Joint Command units; and the U.S. portion of NATO elements.

Determining the number of military who are or will be assigned within each community proved to be a major undertaking. As a forward deployed force, USAREUR does not have all its troops assigned for duty at the same place the guidon is planted. Before we could determine accurate troop population figures, some units' deployments had to be traced down to the squad and section level. Army communities also had to determine how many non-USAREUR military personnel lived within their boundaries.

Our community DEHs needed to know both their present military populations and the projected populations 5 years hence. To get accurate statistics, the DEHs worked with stationing, operations, and resource management personnel. In many cases, the DEHs had to take charge and run the action. The refined community demographic projections they compiled are now valuable, accurate planning documents.

All that work was just one step. The communities still had to identify the number of families who would need housing in Europe.

We quickly decided we couldn't base projections on Army average marriage factors. We discovered that marriage trends vary with different types of units. For example, the Army average indicates 54 percent of soldiers are married. But aviation units tend to run over 80 percent married, while armored units have only about 30 percent married personnel. The community that has a heavy concentration of armored units will have vastly different housing requirements than the community with aviation units.

To get accurate counts on the number of service members who are eligible for BAQ at ***with dependent*** rates, DEHs sought help from finance office computers. In many cases, they went on to confirm the accuracy of those runs at unit level.

Marriage factors for units scheduled to move into a community were estimated by querying the losing community or installation in CONUS.

Another problem is that soldiers don't always bring their families overseas for a variety of reasons. Those who leave their families behind because they can't get adequate housing are people USAREUR needs to provide homes for. Those

American - built housing reflects distinctive European architectural styles.

whose families stay in the States so the children won't have to change schools are not. In order to count the ***voluntarily separated,*** DEHs had to ask unaccompanied soldiers why their families stayed behind.

To do this, they had to ensure each soldier went through the housing office upon arrival in country. At central processing facilities this was fairly easy, but in most communities, DEHs had to make an extra effort to get people to check in and out with the Family Housing Office, even if they didn't want housing.

Refining the requirement—How many homes do we have?

Despite the magnitude of the task, the communities did determine the effective family housing requirement for the next 5 years. Next, we set out to learn what housing assets we had to meet the need. DEHs could easily count government-controlled units and units approved and funded for future construction or leasing. We also identified government-controlled units that we expected to lose over the next 5 years.

The big problem was determining how many private rentals would be available. It is DOD policy that private rentals are the first housing source to be tapped after existing government-owned quarters. But the ***military fair share method,*** normally used to decide what percentage of the private rental market houses military families, proved unrealistic. Each USAREUR community with a housing shortage already exceeded its ***fair share*** of the market and still had a problem.

With DA and DOD approval, USAREUR abandoned the ***fair share*** approach. DEHs were asked to decide how many private rentals in their area were realistically available for Army soldiers.

We also needed to define a suitability standard for rental units. We developed a suitability standard for Europe to ensure that private rentals offer physical features and amenities similar to those in government-controlled units at a price soldiers can afford.

The new standards are a big step forward, although there is still room for improvement. The USAREUR is currently trying to reduce the acceptable commuting time between home and duty station from 1 hour to 30 minutes, and to make other minor changes.

For the suitability criteria to work, each unit the housing office or soldier finds must be inspected for conformance with standards. Then a data base must be built to project the percentage of private rental assets in each community that are truly suitable.

DOD developed a new method, the Segmented Housing Market Analysis, to determine the number of private rental units that should be counted as available both now and in the future. Since the Army found these analyses ate up scarce manpower, most communities decided to contract the work. After 3 years of effort, projections of rentals that are acceptable to all are now being used.

What kind of roofs?—DEHs plan to meet the need

When the complex detective work of determining requirements and assets was done, we could identify shortfalls. Those communities that could house all their families needed no additional government-controlled quarters.

For communities with shortfalls, the real choices boiled down to two: build or lease. The DEHs soon found they had to innovate and engage in farranging, detailed coordination to raise roofs.

The building program. To build from the ground up, communities needed real estate. Most communities did not have much, and found that getting more was either impossible or took time—years, not months. Even if land was available, DEHs often found they couldn't build on it because of elaborate European zoning. That's right, military bases are zoned—and it's no light matter to change the zoning plan.

Many DEHs sought help from local officials to get real estate and/or siting approval for their proposed housing projects. They met with mixed success. By January 1987, we were sure of only 17 locations in Europe where housing could be built.

Where there was no land, we looked at another construction alternative—putting new homes under existing roofs. Most of the more than 40,000 government-owned units in Germany are stairwell apartment buildings with empty or inefficiently used attics. We developed a plan to convert these attics into two-bedroom apartments for young married couples. The first attic conversions are now being built in Mannheim, Germany. Almost 1,700 attic dwellings are programmed through FY 90.

In FY 84 Congress approved the first military housing construction ever funded by the U.S. Government in Europe. (Previous housing was funded by the host nations in the 1950s and 1960s). The law stipulated that the housing must be manufactured in the United States. The challenges we encountered are only suggested when you consider that—

- Host nations had to approve American-made units—which had to satisfy distinctive European architectural design and construction.
- Specifications had to meet both host nation and U.S. standards, and U.S. manufacturers had to be able to meet the specifications.
- Quality assurance was required. Housing had to meet family needs, and satisfy commanders, engineers, DEHs, host nation officials, Congress, and just about anyone else who had an interest.
- New solicitation, award, and contracting procedures had to be developed and implemented.

Military families have contributed to designs for many amenities that ensure pleasant living conditions.

We did it all, and saw the first 107 units completed and turned over at Wildflecken, Germany, in January 1987. Since then, another 49 units have been turned over, and 977 units, mostly town houses, are under construction. The European Division, Corps of Engineers, is presently preparing contracts for 558 more units.

The Army in Europe feels that family members make a valuable contribution in ensuring that housing is the best we can provide. The DEHs consult military families during specification development, proposal review, prototype inspection and approval, construction review, acceptance, and postconstruction critique.

Leasing. The Army's other option is to lease private housing that is

available, or have European investors build housing for the Army to lease.

Finding existing facilities in quantity is difficult. Most European housing located where the Army needs it was leased long ago.

Some communities with large housing deficits have begun to lease single units rather than apartment buildings. This complicates management, maintenance and repair, and utilities problems. But the soldiers live among European neighbors and are truly integrated into the host-nation community. To blend well culturally, education for commanders, soldiers, and family members is important.

An offshoot of this approach is being tested in three communities. In this test a soldier finds a unit on the economy within price and safety guidelines, and agrees to live in it for a whole tour. The government rents it (holds the contract), ensures maintenance is done, and provides utilities. The soldier gives up his BAQ.

USAREUR hopes to answer several questions. Are these units comparable to government-controlled units? Is the approach cost-effective? Are sponsors, families, and landlords satisfied? What other problems arise? How can they be solved?

It took 6 months to gain DA approval and 13 months to get the nod from the German government before the test could start. The program appears to be a winner. If so, we will seek approval and funding to expand it.

Build-to-lease is another option. Under this program, private investors construct housing on private land to lease to the Army. But specifications must be developed, and solicitations and negotiations conducted. Entrepreneur interest must be elicited. Often local political approval of projects is required. Construction must be monitored. The building must be accepted and then managed. Each of these tasks is either done or monitored by the DEH.

At the end of February 1987, 14,334 military families in Europe lived in government-leased housing. We now have 3,025 more units under contract, and hope to have a total of 17,500 build-to-lease units in Europe by the end of the year. We are asking Congress for authority to negotiate additional leases.

There are many variations on the construction and leasing plans described here. Each DEH must choose the combination that will best eliminate his community's housing shortfall. Successful DEHs remember the art of the possible—avoiding plans that can't be executed.

The Family Housing Acquistion Plan

Each DEH has developed the Family Housing Acquisition Plan (FHAP) that now forms the basis for all programming and planning for housing acquisition in Europe. The FHAPs attempt to meet 100 percent of the housing requirement. This exception to DOD policy is a key element in assuring that every family will be housed by 1991. One hundred percent programming has a price. It requires more detailed planning, justification, and monitoring.

But plans are not homes. Plans just lay out what DEHs want to do. They must ensure that projects are justified . . . requested . . . programmed . . . sold to USAREUR, DA, DOD, and Congress . . . funded . . . designed . . . executed . . . accepted . . . and managed.

Even when there is a roof for every family, DEHs will still be challenged to distribute the homes so that the Army, commanders, soldiers, and family members are best served and satified.

COL Daniel G. Barney is the project manager for housing acquisition for USAREUR. He previously served as the chief of the Facilities Engineering Division, USAREUR.

Lease and rental programs provide more housing for Army families

by Jo Simpson

The Army needs flexible options to help it meet housing needs on all installations. On posts where housing is scarce and the local economy is healthy, the Army's build-to-lease and build-to-rent housing programs are good ways to make homes available.

The program allows the Army to arrange for a private developer to finance, build, own, and maintain facilities the Army needs. In return, the Army agrees to lease the units from the developer.

Authorized under Sections 801 and 802 of the Military Construction Act, these programs can be tapped when the Army shows Congress a saving of 5 percent or more over military construction.

While housing built with government funds may be 5 years in the making, lease and rental projects built with private funds can be designed and constructed as soon as contractors obtain financing.

Build to lease or rent isn't feasible on remote posts like Fort Irwin, California, which has no independent housing market, or like Fort Ord, California, where land costs are very high.

But where it does make sense, the program can be an important part of the mix of housing options. Congress authorized the Army 4,000 lease units and 1,800 rental units in 1984. The Army has asked Congress for another 3,500 units to be built in 1988 and 1989. These new units will help to fill the gap in several rapidly expanding military communities in the continental United States.

Bidders for these lease or rental projects design housing units according to Department of Defense (DOD) requirements. The Corps of Engineers reviews the designs, and awards the bid to the design that gives the best house for the money. In Alaska, for example, the contractor has observed government-owned housing specifications for floor space, but has built in amenities such as attached garages, wall-to-wall carpeting, and hardwood trim.

New homes can be ready within 2 years. Families at Fort Drum, New York, have begun moving into a 1,400-unit build-to-lease housing project, which will be fully occupied next year. Families are also moving into the first group of 400 new build-to-lease houses at Fort Wainwright, Alaska. The first group of 300 units at Fort Polk, Louisiana, was recently completed.

The Army is currently advertising for 1,000 more units at Forts Drum, Wainwright, and Bliss, and on Oahu, Hawaii.

No build-to-rent housing has yet been built. Though four projects have been approved, one drew no bids, and the contractor cancelled another after failing to get financing. The other two projects are still trying to get financial backing.

Build-to-rent projects are based on the soldier's housing allowance. "Since the projects are targeted for lower enlisted grades, the contractors have difficulty getting financial backing to build affordable units," said John Kneuven, housing management specialist at the Office of the Chief of Engineers. "The Army is doing everything possible to make the program work."

To make the projects more attractive, Congress recently changed the guaranteed rental period from 15 to 25 years, and permitted the entire rent amount to escalate along with the soldiers' housing allowance. New tax laws may also help the projects attract financing.

"Build to lease and rent are good solutions for the large housing deficits at places like Fort Polk and Fort Drum," says Kneuven. "They complement government construction. The Army couldn't afford to build the amount of housing required, and neither would we want all lease or rental housing. We need a mix of programs."

Jo Simpson, former Public Affairs Officer for the Facilities Engineering Support Agency, is now a marketing executive for the U. S. Department of Justice Federal Prison Industries.

Personal Viewpoint (Continued from inside front cover)

mander will still look to his DEH and expect responsive, timely support.

That means those who are close to and understand the work must be given time to prepare thoughtful ***performance work statements*** and allied documents. Only the DEH staff knows the installation, its peculiarities, and its needs well enough to make sure the contract covers the bases.

To keep the work in house, the entire DEH organization must commit to making changes in jobs and grade structure that will give it a competitive edge. The DEH organization that strives to protect its work force or preserve business as usual loses to a contractor every time. The DEH must be honest right up front. To preserve an in-house work force, more will have to be done with less. And win or lose, jobs will change. Only then can the DEH hope to achieve a competitive ***most efficient organization.***

Stanford C. Draper is Chief of the Utilities Division for the VII Corps DEH in Stuttgart, Germany. He was the Chief of the Contract Support Branch at FESA from 1985 through 1987. He was the Facilities Engineer at Fort Ritchie, Maryland, from 1973 through 1983.

HOMES modernizes Army housing operations

by Suzanne G. Edge

"I wish I had a magic wand...." As Army housing managers deal with frustrated customers each day, the thought of a magic wand ***does*** come to their aching heads. Though Army research and development hasn't invented a magic wand, the Fort Bragg housing staff recently tested an automated system that's better than aspirin—it makes many housing headaches go away.

The Housing Operations Management System (HOMES) streamlines the Army's housing business and gives better service to soldiers. After successful testing at Fort Bragg and Fort Drum, the U. S. Army Engineering and Housing Support Center decided to install HOMES programs at other Army installations worldwide. Judging from Fort Bragg's successful experience, soldiers and housing staff alike are going to be happy with HOMES.

Cutting the irritation factor

The housing offices at Fort Bragg stay busy. In 1986, they had more than 38,000 visits to the on-post housing office and 14,000 customer visits to the off-post housing referral office. That doesn't count ***any*** phone calls.

Just by replacing pencils with computer terminals, HOMES has made serving customers much easier. The sight of modern equipment tends to portray an efficient operation in soldiers' eyes, and gives them confidence that they will receive good service.

Fortunately, HOMES gives more than a good first impression—it works. When soldiers apply for housing, the housing clerk enters the information into the computer. Based on the information fed in, the system will calculate the waiting time for quarters and place soldiers on appropriate waiting lists. HOMES will also correctly position soldiers on waiting lists—such as soldiers who receive credit because of restricted overseas tours, those in key and essential positions, and so forth. The system affords a soldier the opportunity, at any time, to check his position on the waiting list, so he can make the appropriate arrangements off post while awaiting family quarters on post.

Before HOMES, the Fort Bragg housing office used an out-of-date computer punch-card system that left soldiers feeling like victims of a slow-motion runaround. The system—called the Housing Management Information System (HIMS)—required keypunching new cards each time someone moved in or out of quarters.

The system couldn't establish waiting-list priorities or positions for soldiers returning from unaccompanied tours (it only sequenced by an eligibility date). Customers were suspicious, because housing offices had to manipulate their eligibility dates to establish their positions on the waiting list below the freeze zone.

After all this effort, the cards were submitted to the installation computer office once a week. The results were printouts of the waiting lists and quarters listings, which were both nearly a week outdated when received. Now HOMES provides Army families and staff on-the-spot answers and makes adjustments invisibly—reducing the irritation factor for customers and employees alike.

HOMES has also cut the cubic yardage of paper at the housing office. There is no longer a requirement to maintain history cards on each dwelling unit, nor the lengthy application. Since punch cards are no longer necessary and most of the record files are stored in the system, Fort Bragg has eliminated file boxes and drawers full of paper—most of which were cumbersome to use and took up valuable office space.

Streamlined moves

The HOMES system has streamlined check-in, inspection, and checkout for families and personnel of the housing office. Before HOMES arrived, housing personnel kept appointment books for all inspection appointments. Usually several people needed the books at the same time. Now inspectors and clerks can use their own computer terminals to schedule appointments and check information.

Housing inspectors can now hand soldiers their termination orders as soon as an inspection is complete, thanks to HOMES. The system will print the orders before the appointment; the inspector carries the occupant's copy to him if all clearing requirements are met. This feature alone has saved soldiers many hours of leg work, since many times finance records have been closed out during clearing post, and reinstatement of basic allowance for quarters may not be posted in the finance records.

HOMES also gives inspectors an information checklist for the dwelling, which includes the number of baths, the square footage, paint and floor dates, modification for the handicapped, and other vital statistics. At the inspection, the housing inspector has all the data to determine the necessary maintenance.

Better housing referral services

HOMES has greatly enhanced referral services. Off-post rentals and sales used to be listed in notebooks by type and number of bedrooms. If several families had the same requirements, they got in line for the book.

Today customers simply state their needs to the housing counselor—size, location, price range—and HOMES immediately provides a printout of the available units meeting the criteria. The soldier has a listing from which to begin seeking his home. The HOMES system also records landlord-tenant complaints, which the housing referral staff can use to determine whether problems are starting with a particular landlord or whether a soldier is initiating problems wherever he lives off post.

Customer feedback is vital to ensure soldiers can find affordable, adequate housing. Soldiers are given a feedback card to return to the referral office. For customers who forget to return their cards, HOMES prepares a reminder letter. This is kept track of by the system—not by the clerk.

Speedier housing analysis

HOMES helps the housing office to prepare more accurate housing analysis and survey reports in a shorter time. Results are available almost instantly after the completion of the Segmented Housing Market Analysis and pertinent strength and stationing input data. The previous survey system was submitted to the Department of the Navy for results and took approximately 6 months to process.

Civilized billeting

HOMES has eliminated reservation books in the billeting office. Formerly, guests' names were on one list, and available rooms on another. Billeting personnel did not know which rooms guests would occupy until they walked through the door and registered.

Now Billeting operates as an efficient hotel. The computer assigns rooms to everyone with a reservation. Guests walk in and immediately receive a room number and key. The desk clerk can check the computer to see if a room has been cleaned for a guest arriving early. HOMES provides for group room blocking, statements of nonavailability, guest lists, automatic billeting, and all reports for financial purposes.

Close to magic

No system can magically melt complex management challenges, but HOMES can give managers more time to devote to challenges and can eliminate time wasted on everyday manual tasks required to operate the business and generate reports. After training, hard work, and long hours, housing managers will find that HOMES is a wonder-working tool that improves customer service and trust. HOMES lets the Fort Bragg housing office serve customers more efficiently. Everyone has fewer headaches. Now we wonder how we managed without it.

Suzanne G. Edge is chief of Family Housing Branch at the Fort Bragg, North Carolina, DEH. She has been involved with HOMES since 1981, and has seen both the Assignment and Termination Module and the Housing Referral Module come to fruition. She has also enjoyed seeing the implementation of billeting and furnishings management modules.

DEH customer relations—
Success at Fort Stewart

by LTC Michael E. Stovall

What if every Director of Engineering and Housing had a customer relations specialist at his ear?...A mid-level manager with direct access to the boss, devoted entirely to ensuring the organization served customers well?

Most service industries—be they utility or telephone companies—long ago learned the value of hiring professionals who listen to customers and work as their advocates.

The DEH is like a city manager who provides housing and maintains a host of facilities from training areas to hospitals as well as the traditional array of services like roads, sewer, water, heat, electricity, and fire protection. No other organization on post more directly affects the living and working conditions of soldiers and their families.

Yet most of us struggle constantly against perceptions that the DEH is an unresponsive bureaucracy that simply doesn't care what soldiers and their families want or need.

Decide to succeed

In 1984, my predecessor, COL James I. Spencer, decided what was good for industry was good for Fort Stewart. He set out to hire a customer relations specialist to take an objective look at customers' problems and how they were handled.

It wasn't easy. Customer relations is not a mission recognized by manpower survey teams or an occupational specialty that CPO job classifiers readily understand. To get the program started, the DEH created an overhire position out of existing resources. Efforts to win Army recognition for the mission and profession are continuing.

At Fort Stewart, the benefits for both customers and the DEH have been overwhelming. In two short years, the DEH cut customer complaints on service orders from 7 percent to less than ½ percent (industry uses a 3 percent complaint target). This is a business improvement that is clearly worth fighting for. In the

Fort Stewart's DEH, MAJ Stovall, and Mrs. Jeanne Adams, Customer Relations Officer, make an on-site visit to examine a potential playground hazard.

The Customer Relations Officer reviews architectural plans for family housing with the DEH.

last year, at least 18 other DEHs worldwide have joined the struggle to make customer relations specialists part of their staff.

Fort Stewart is home to more than 30,000 Army family members. Like dozens of Army installations, it had too little money and manpower to satisfy demands, a work force with limited time or opportunities for training on the secrets of customer-oriented service, and poor communication both internally, between DEH divisions, and externally, between staff and customers.

Train everyone

The first priority for the new Fort Stewart customer relations officer was to raise the customer consciousness of the DEH work force—to start change from within. She developed a 4-hour customer relations training program for the entire DEH work force—from the newest, lowest grade employee to the director himself. The director's willingness to support and participate in the training program guaranteed committed staff at every level.

A big problem turned out to be that many employees never had a clear picture of their organization. They only knew what came across their desks or through their offices. This inadvertent tunnel vision frustrated employees and made it impossible for them to direct problems they couldn't solve to the proper person. The training program helped employees see how they fit into an organization of interrelated divisions that support soldiers and their families.

Most important, the program explained how to achieve something we all strive for but often lose sight of under pressure—clear, courteous communication between staff and management . . . between personnel and customers.

The DEH learned to speak the language of caring, thanks to total immersion training—the same training that works best for people learning to speak a foreign language. Fort Stewart's program emphasizes role playing. Employees put themselves in both the customers' shoes and those of DEH employees who handle their problems.

They played the parts of—

A tired soldier who returns from field duty to find there's no hot water in the barracks. Furious, he calls an overscheduled maintenance employee, who must take care of him . . . and all the other hot priorities already on her list.

A young officer's wife who is trying to cook dinner for her husband's boss on the faulty burner she reported 2 weeks ago—in tears, she calls DEH for help.

A DEH supervisor who is caught in the midst of a conflict between the interests of employees, higher officials, and customers whose needs must be balanced in a single afternoon.

Once they tried it, Fort Stewart employees were enthusiastic about stepping into the other guy's shoes—even the managers, who were reluctant at first.

The ***esprit de corps*** nurtured during training was reinforced with an awards program that recognizes customer relations and job achievements. A collage of color photos in the DEH lobby that now features DEH projects and people at work has paid surprising dividends in improved employee morale.

Inform customers

A confused, troubled customer is difficult to help. On the other hand, people who know where to go and how to lodge a complaint can usually be taken care of before they become totally frustrated. The second priority for Fort Stewart's customer relations officer was to educate customers on how to request service in both routine and emergency situations.

The program teaches troops about troop- or unit-related services. They learn how to fill out work requests, how to identify problems and track the status of projects through the DEH.

New family housing occupants learn how to place service orders and cope with emergencies until help arrives. Spouses are taught how to change light bulbs, check and replace fuses, perform simple repairs, or quickly smother a grease fire. Everyone benefits—the DEH, the family, and the soldier in the field.

An unhappy customer needs a sympathetic ear . . . someone who has time to understand the problem and track down what went wrong.

The work order section has its hands full handling service orders, job estimating, and scheduling. In the absence of a customer relations officer, the DEH and his deputy frequently find their personal energies devoted to coping with disgruntled customers at the expense of improving management.

At Fort Stewart, any customer who has called in a routine or emergency request to the DEH and isn't satisfied with the results is referred directly to the customer relations representative, whose job is to get to the bottom of the problem.

Use what you learn

From a management perspective, perhaps the single most important payoff from a customer relations office is the ability to qualify and quantify complaints. Knowing you have "a lot" of complaints isn't helpful. To solve problems, you have to identify the types of complaints and how numerous they are.

The customer relations officer developed a system for categorizing complaints for the DEH's two major areas of concern: family housing administration and barracks work. Complaints are coded into the following categories:

- Excessive response time.
- Excessive repair time.
- Poor communication between sections involved in the repair.
- Failure to notify customer to meet the repairman.
- Discourteous repairman.

The customer relations officer uses complaint data to prepare statistical analysis for monthly DEH staff meetings. Where trends arise, the DEH reviews procedures and looks for ways to solve the problem.

The commanding general reviews the complaint data during quarterly review and analysis meetings. The DEH now has a clear track record on how problems are solved, and the commanding general can tell at a glance just how well DEH is—or isn't—managing its affairs.

Don't neglect public relations

The customer relations office should take every opportunity to make public relations work for the DEH and customers. The DEH at Fort Stewart actively participates in all groundbreaking, ribbon-cutting, and dedication ceremonies involving the directorate. This gives the DEH a chance to reinforce to the public the many services it provides, and the work force takes pride in seeing the engineer flag flanking the commanding general's in public.

The customer relations officer also works closely with all quality of life personnel and attends all mayor's meetings, town hall meetings, and various council and installation meetings that involve community activities. This official point of contact for inquiries, requests, or complaints involving our community has led to a solid, congenial relationship between our organization and the various quality of life offices on the post.

Besides publishing articles in the post and local newspapers about DEH activities, the Fort Stewart DEH also publishes a quarterly bulletin to keep customers informed about the latest policy changes or to publicize new services.

One such service is the Dial-the-Engineer line. This telephone service, modeled after the Dial-the-Boss line, gives customers the chance to call the DEH himself about any problem they think deserves his attention. He reviews all taped calls each morning, and can direct necessary action to resolve a problem. The caller is contacted within 24 hours and given either a status report or completed action report on the problem.

It should be noted that Fort Stewart's feat has not been an "overnight success story." It has taken the DEH 3 years to build this rapport with its customers.

This program has been aptly called innovative, daring, even risky. But the results have more than outweighed any risks associated with change. The customer relations office channels communications between the DEH and his work force and also between the DEH and installation customers. That is the real secret of the DEH's success in meeting its goals—committed employees and informed customers working together.

In the fall of 1987, MG Michael F. Spigelmire, Commanding General, 24th Infantry Division (Mech), honored Fort Stewart Customer Relations Officer, Jeanne Adams, with the Commander's Award for the program's outstanding contributions to the morale of the soldiers and their families.

Any DEHs interested in the program may contact Mrs. Adams, 24th Infantry Division (Mech) and Fort Stewart, ATTN:ASZP-DE, Fort Stewart, Georgia 31314-5000, telephone: (912) 767-8356, AV 870.

LTC Michael E. Stovall has been the Fort Stewart DEH since June 1986. He has also served as the Fort Stewart Operations Officer.

ROOM SERVICE— *TRADOC's transient housing certification program*

by Bonnie Handzlik

In 1985 TRADOC's commander challenged installations to improve Army guest housing and TDY quarters to meet the standards of the hotel and motel industry.

How well have we done? In 1986 I was part of an evaluation team that surveyed TRADOC installations to see how comfortable life is for traveling soldiers.

We put our shoes in guest closets and our heads on guest pillows to find out first-hand how comfortable guest quarters really were. We assessed the quality of check-in, check-out services, the conveniences in common areas, and the comfort and attractiveness of rooms. We think our travel diary will help you to spot problem areas and suggest ways to further improve your installation's transient facilities.

Our first recommendation is that you test your accommodations by staying in them. We know from experience that you'll quickly learn what's comfortable and what needs to be fixed.

Arrivals

Like all travelers, our team was ready to breathe a sigh of relief when we reached our destination—not to feel discouraged and lost. Yet some installations had no signs, and we had to stop several times to get directions. Make sure arriving guests feel welcome as soon as they reach the main gate; install clear directional signs to the guest reception area.

We felt reassured when a prominent, attractive, well-lighted sign welcomed us at the billeting office. Landscaped, well-maintained grounds and buildings told us right away that we were on a well-run post. A protected loading zone at the billeting entrance eased guests' arrival. We appreciated automatic doors large enough to accommodate luggage.

First impressions set the tone for what your customers expect during their visit. Drive out to the front gate and look at your facility with fresh eyes. Can you find your way? Would you think "I'm happy to be here?"

The team found that reception areas lift or dampen spirits. Forts Lee and Belvoir, in Virginia, greet guests with lobbies and reception desks that look like those in high-quality hotels. Fort Lee offers a tour and information office in the lobby—a real convenience!

But there were also drab, uncomfortable lobbies where the team stood dismayed. At some posts customers enter cramped reception areas with homemade-looking counters. At one, the front desk was enclosed in forbidding wire mesh. If the reception area is dismal, fix it. Don't hesitate to get interior design assistance.

On the inside

Lounge areas. Pay attention to lounges, vending areas, and central kitchens. Guests should be able to get a quick snack or drink, buy some toothpaste, wash their clothes, meet colleagues, or cook a meal when they are away from home—pleasantly and conveniently.

Fort Gordon, Georgia, stood out. The clean, well-furnished common areas were decorated with large plants and pictures and equipped with game machines, ice machines, microwaves, and well-stocked vending machines. The team quickly felt at home.

On the other hand, we avoided common areas at several posts. Guests can't relax in a dirty, ill-maintained lounge furnished with mismatched or damaged furniture. Empty vending machines were especially frustrating. Some posts had no convenience machines at all. Check your guest quarters. Could you comfortably take a break in the lounge—or would you feel like you were in a run-down urban bus station?

Laundry rooms. We were frequently disappointed with laundry facilities. Most needed repainting, floor covering, and other repairs. Visit the guest laundry room, and stay long enough to wash a load of clothes. There are usually too few washers and dryers, no detergent vending machines, and no tables for folding clothes. The team found most laundries uncomfortable and distasteful. So do soldiers on the move with their families.

The team also found maids washing the guests' sheets and towels all day in some laundry rooms. This is a misuse of both the maid service and the laundry room. Maids should clean rooms; a laundry contract should take care of hotel linens.

Hallways. Finally, make sure the hallways are attractive and well-lit. Don't turn off lights in the hallways to save energy, as one installation did. It's unnerving at best, and may prove unsafe.

This lobby at Fort Belvoir, Virginia, greets guests as pleasantly as any commercial accommodation.

Accommodations

Hotel-style rooms. Guests need a pleasant room or suite where they can work, relax, and get a good night's sleep. They will overlook many other shortcomings if the rooms are comfortable. The team stayed in some rooms that easily rivaled those in quality hotels. The hand of an interior designer was usually evident in an upgrade that made good use of both appropriated and nonappropriated funds.

Other installations only went halfway. Attractive furniture and amenities were wasted in rooms when mixed with mismatched or bargain basement artwork, draperies, or carpet. G.I. ribcord bedspreads, sagging mattresses, rusted metal trash cans, lumpy pillows, and retired barracks furnishings stood out like sore thumbs. The guest quarters shouldn't look like they are furnished with Army surplus.

Many installations claimed this was the best they could buy. Not true. The GSA schedule includes many fine items.

Student accommodations. Most TRADOC installations have rooms used primarily by long-term TDY students who need work areas and storage space. Well-designed modular furniture is a must.

At Fort Leonard Wood, Missouri,

The attractive interior design evident in this room at Fort Belvoir exemplifies what installations can do to make their guests comfortable.

a professionally designed custom unit—available from Federal Prison Industries—provides work space for a personal computer and extra storage for books, field gear, and personal items. Other companies also offer modular furniture on the General Services Administration schedule.

Rooms should be functional and attractive, with good lighting and convenient electrical outlets, especially in the work area. Bathrooms need a cosmetic shelf or vanity counter. Arrange the furniture so guests can work or watch TV comfortably.

Amenities

Small amenities help make up for the inconvenience of not being at home. Most posts now offer complimentary toiletry items. We especially liked Fort Benning's selection—two small plastic bottles of brand-name shampoo and mouthwash, a small sewing kit, a shoeshine cloth, a snack-size packet of Georgia peanuts, and a peppermint candy attached to a small card that reads "You're worth a mint to us."

The team also appreciated Fort Benning and others that offered larger, thicker bath linens and brand-name larger bars of soap. Guests also appreciate a small coffee maker with a few complimentary packets of instant coffee or tea. A copy of the welcome magazine from the installation's permanent change of station packet was always helpful.

On the other hand, a few installations gave the impression they thought their guests were scoundrels or worse. Their hospitality brochures included a list of room furnishings and warned guests to report missing items at check-in or be held accountable. These must go! The housekeepers should inventory items—including drinks or snacks sold in the room—at checkout.

Telephone service

Telephones were available or planned for all rooms. Some systems included Autovon access—an important service, since most guests need to make business calls. Make Autovon available at the main desk if it's not in the rooms.

It's a big job to offer traveling soldiers and their families the comforts of home, the convenience and appeal of a hotel, and the amenities of a study or office. The team was impressed with the progress TRADOC installations have made. We look forward to finding this year's visits a real pleasure.

Bonnie Handzlik is the TRADOC housing management specialist for transient housing policy and programs.

The New Integrated Facilities System (IFS-M)—

a user-developed automated system for DEHs

by Jo Simpson

The new Integrated Facilities System Micro/Mini (IFS-M) will solve most of the problems that have made the old IFS synonymous with frustration.

The IFS is DEH's management tool and data base for such things as inventory, job cost accounting, and job status.

The earlier design was a classic development with classic problems. Representatives from DEHs wrote the functions and requirements for the programmers; then the programmers went to work and the people who knew DEH business went away.

The result was a system that wasn't flexible, convenient, or capable of doing the job for the DEH.

The Army has been redesigning IFS for several years. Originally, redesign was planned for mainframe computers at the Army's Regional Data Centers across the country. But the Army realized that IFS belongs on a minicomputer at the DEH since much of the data is only used at the installation.

Installation DEHs should start receiving IFS-M in May 1988. Current plans call for IFS-M to be installed at 13 to 16 sites a month for a total of 143 installations in 18 months.

There will be no more truckloads of printed reports; no more waiting several days to get information back from the installation computer center; no more suffix codes that are difficult to remember.

DEHs will have instant access to data and be able to reformat it. Records will be updated and reports provided as soon as new information is entered. Users will be able to query IFS-M quickly and conveniently.

"We wanted IFS at the DEH and tailored to what the work order section and other functional areas do day in and day out," said Luther Oswalt, IFS-M project manager for the U.S. Army's Engineering and Housing Support Center (EHSC). "Upward reporting should be a natural byproduct of their work. We wanted to include microcomputers so folks can bring data off the minicomputer and use it for purposes other than IFS."

Probably the most important difference between IFS-M and its predecessor is the development process.

"I truly believe IFS-M will be the best management system in the Army, because it is the only one being developed with ***full*** user participation," Oswalt said.

The IFS-M design process began last summer with a requirements analysis and planning (RAP) team. Nine installation DEH employees received a week of training and spent 8 weeks establishing a basic plan for each major area of DEH work.

They quickly found they couldn't lay all the ground work for IFS-M in one session. A separate RAP group for finance began in February, and one for contracting began in March.

"The RAP groups bring users from MACOMs and installations that are involved in daily work management functions to help with analysis and planning," said Jack Malone, chief of EHSC's IFS support branch at Fort Lee.

"The RAP sessions start people thinking about what they do," said Terrie C. Whaley, Anniston Army Depot. "We discuss what seem to be different things for a while and then find that we are talking about the same thing."

"Even though IFS-M will be standardized, it also will be more flexible than IFS," said Sonja M. Patrikios, Ansbach Military Community, West Germany. "Installations should be able to use the system for their unique needs."

When the RAP groups finish, prototype development model (PDM) teams take over. Each PDM team consists of three people from EHSC and one from the Information Systems Command's Systems Development Center at Fort Lee.

They are assisted by people from installation DEHs who come at intervals to review the work and suggest improvements.

The PDMs are small segments of business that can be developed in detail. "We divide the work so that each segment can be developed into a subsystem in 6 months," said Malone.

The PDM teams develop a model of how to do business and how data interrelates to support tasks. They also develop rules for doing business. The PDM team designs the subsystem and writes the program.

"We spent a whole week designing the service order screen, " said Jean Lawson from White Sands Proving Grounds, New Mexico. "We worked on each field and tried to accommodate the needs of each type installation."

Most existing DEH systems such as the Facilities Engineering Job Estimating system (FEJE) will be incorporated into IFS-M. The system will meet DEH supply management needs. The housing operations management system (HOMES) will remain a separate system, but it will interface with IFS-M.

The Chief of Engineers is the proponent for IFS. The EHSC is managing the development and training, and the Information Systems Command's Systems Development Center (SDCL), Fort Lee, is doing the programing."

Thanks to the DEH resource managers, work order receptionists, and others who are giving us their expertise, I believe IFS-M will be excellent—maybe not bells and whistles, but excellent," Oswalt said.

Installation Support—

The Army facilities business is like a real world kaleidoscope. We no sooner get a firm fix on one problem than the pattern shifts and a new challenge emerges. There are both satisfactions and dissatisfactions in the facilities business . . . but little boredom!

A few years ago, Army Directorates of Engineering and Housing and their supporting Corps of Engineers Districts undertook the monumental task of modernizing antiquated military facilities worldwide: Some in Germany were so old that they once sheltered Hessian troops training to fight the American Revolution . . . . Many in Korea were tin huts hastily erected to support the conflict . . . . And thousands of aging U.S. facilities were built to prepare soldiers for combat during World Wars I and II.

Thanks to engineer efforts, the Army now has a facilities strategy to provide adequate housing for soldiers and their families, to get equipment out of the mud, to eliminate deficient work areas, and to support AirLand Battle training, force structure, and equipment.

We have made massive progress toward those goals. We might be tempted to congratulate ourselves and press on.

But the Army is in the throes of a major change in the way installations are managed. That change demands more than ever that the DEH become a lean and efficient management machine to survive. Never losing sight of the unfinished business, we must frame a new vision of installation management that is equal to the challenges of a new decade.

This is a time of reflection and scrutiny for the total Army, not just for those of us who work in the DEH business. It may then be premature to speculate on the future. But I want to outline the issues that are clearly before us and solicit your thoughts and discussion.

Together, DEHs, district engineers, and those of us who are headquarters advocates for engineering and housing programs must combine our talents and seek new ways to support our customers in an environment influenced by privatization, organizational change, fiscal constraint, deregulation and decentralization, and new technology.

Privatization

National policy is to rely on commercial contractors for goods and services whenever it is cost effective. Over 50 percent of the Army's maintenance and repair work is now performed by contractors. The DEH staff's energy is shifting away from day-to-day in-house operations and is increasingly on planning, programming, and contract execution.

Yet commanders will continue to turn to their DEHs for traditional facilities support and expect responsiveness, especially in emergencies. We need to take a cost effective, responsive, customer-oriented approach that embraces the ***competitive spirit.***

Organizational change

Experiments in consolidated BASOPS—particularly RPMA and logistics support—are under way at several installations where commanders saw an opportunity to improve efficiency.

This challenges many long-cherished notions of professional responsibility for both the DEH and the Directorate of Logistics. However, we recognize that some consolidations are necessary and beneficial to the Army. Clearly DEHs and the Corps need to be at the forefront of this major transition. We must help shape and test this change, not just react to it.

Our efforts to revitalize the Army's deteriorated facilities have taught us valuable lessons in engineering and housing management, in master planning, and in repair, maintenance, and construction contract execution. The complexity and political sensitivity of the business cannot be oversimplified. Engineering savvy and technical expertise are integral to sound facilities management judgment. RPMA support works best when an engineer reports directly to the installation commander. It is no accident that the Chief of Engineers in the Pentagon no longer reports through another senior staff member.

Fiscal constraints

Astute use of funds is essential to protect the Army's facilities investment. Commanders cannot afford an Army that is equipped with the latest tanks but relegated to maintenance shops that are falling down or are inefficient working places.

When our operations and maintenance (OMA) dollars are diverted to other missions and training, the Army will have surrendered to the same philosophy that led to the deplorable facilities conditions that were a blight on morale and readiness just a few years ago.

Engineers have a responsibility to ensure commanders understand the consequences of neglect. This makes it more important than ever for DEHs to know and understand their cost of doing business. They must be prepared to provide tough, cogent advice to their installation commanders. They must therefore be armed with analysis that makes the tough resource management choices clear. Customers and taxpayers will continue to demand quality within a reasonable time at a reasonable price, what I call the "three-legged stool" that we must provide.

Planning

The Army is shifting to a more unified planning/programming mode. Those unprepared to participate are

New Challenges Beckon

likely to find their installations underfunded to carry out their programs. Day-to-day pressures will not excuse installations from programming for the future—10 to 20 years out.

As stewards of over half of the average installation's base operations budget, DEHs will need new and more focused skills in financial management, work planning, contract management, and decision making.

We must ensure that our recruitment, retention, and training programs develop leaders who are well prepared to plan and fight for excellent installations. The Army's call for the "warrior ethic" has special meaning for the engineer!

Deregulation and decentralization

DOD is moving to cancel or revise regulations that unnecessarily limit commanders' freedom to do their jobs. More authority is going to installations. There will be more room for innovation but fewer safety nets to prevent violations.

DEHs, their commanders, and their customers must be able to clearly understand the constraints—legal, regulatory, and resource—placed on the DEH. Concise DEH policy is essential. We must also ensure that smart innovations and ideas are recognized and shared.

The facilities engineering and housing management voice on the HQDA staff after the recent reorganization remains the Chief of Engineers and his Assistant Chief of Engineers (ACE). With the shifts, the newly created U.S. Army Engineering and Housing Support Center provides the Corps and DEHs a strong advocate and focal point for procedural interpretation, technical engineering support, and a sounding board for ideas on how to serve our customers better.

I made a deliberate decision to give the DEH two "Washington advocates" in addition to myself. Between the Army staff and the secretariat, the ACE is our day-to-day Pentagon DEH voice. But at the new Center, a Senior Executive Service civilian heads our DEH operational arm.

New technology

Advances in engineering and automation offer many promising methods for cutting costs. The DEH is inundated with a tremendous amount of ***advice*** on a staggering array of competing systems. We must tap industry expertise and the Corps laboratories' research and development capability so we can evaluate and transfer applicable new technologies to the field. We must avoid the "not invented here" syndrome and capitalize on new techniques, products, and ideas that enhance support to the Army.

Complex environmental issues

DEHs have long been managers of the Army environmental program. But the days are gone when they can shoulder that responsibility alone.

When air and water quality were the nation's environmental watchwords, the Army focused its efforts on pollution abatement for sewer, water, and heating plants—classic DEH functions. We relied mainly on engineering technology to meet the challenge.

Today the emphasis is increasingly on hazardous waste management and minimization . . . issues that touch on people and how they do business. The solutions lie not solely in technology, but primarily in how the Army lives, trains, and operates.

Recent legislation affects all aspects of the installation support mission, including procurement, supply, training, transportation, operations, and medical services.

A more cohesive, coordinated environmental program that involves the entire installation support staff is critical to meet the challenges ahead.

AirLand Battle

While DEHs were modernizing facilities, the Army was devising a new warfighting doctrine. We must ensure that transition to war plans provides for the restoration and operation of critical utilities and facilities essential to win on the battlefield of the future. Engineer officers must be prepared to carry out these vital responsibilities.

Onward

Army facilities have seen vast improvements over the past 7 years. We have benefited from strong administration support and substantial funding from Congress. DEHs have worked hard with their commanders to spend the money wisely and program long-term improvements. They have sought and found innovative measures to design and contract work far beyond their in-house capabilities.

Thanks to their industry and imagination, and the cooperation of district engineers, we have forged a proud Corps of Engineers' tradition as guardians of quality of life for soldiers and their families.

New challenges beckon in the 1990s. But the lessons of the 1980s will stand us in good stead. We belong at the vanguard of installation support. Let us turn our eyes to the future and view it with open minds.

I look forward to hearing from you.

E.R. Heiberg, III
Commander
U.S. Army Corps of Engineers

Military construction programming—
Success in Korea

by COL Carl O. Magnell and
LTC Robert E. Jalette

Soldiers who served in Korea in the 1960s and 1970s remember it well . . . shivering in temporary ***silver bullet*** quonset huts and making cold treks outdoors to the latrines and showers.

Some Eighth Army soldiers still live with those discomforts. But many more enjoy new barracks, new maintenance facilities, new fitness centers, and new morale, welfare, and recreation (MWR) facilities. It's all part of a minor miracle—the facilities renaissance in Korea.

How does a small MACOM realize $572 million of Army Military Construction (MCA) in 7 years, and program growth from $1.6 million in 1980 to $130 million in 1987?

The command has worked hard to clearly portray the difficulties that inadequate facilities pose for soldiers to those who underwrite the budgets for new construction and facilities renewal—from DA and DOD to Congress and the Executive Branch.

EUSA earned strong support by carefully structuring its building program to meet high priority missions first.

The command's internal planning process has also been rigorously disciplined so projects receive the same intense scrutiny from EUSA that they get from DOD and Congress.

The reward? Only excellent projects are forwarded for approval and EUSA's soldiers are seeing temporary quonset huts give way to modern barracks, dining halls and maintenance bays.

Since 1983, EUSA has built 579 new facilities, including—

169 barracks.
11 dining halls.
84 maintenance facilities.
95 utilities facilities.
84 operations/training facilities.
76 supply/storage buildings.
78 MWR (MCA/NAF) facilities.

EUSA programming structure

EUSA is a small MACOM with over 100 camps scattered across the southern half of the Korean peninsula. It accounts for about 6 percent of the Army's real property maintenance budget.

All facilities engineering and housing support in the command is centralized in a major subordinate command under the Assistant Chief of Staff, Engineer. This organization-Facilities Engineer Activity, Korea (FEAK)— gives flexible, centralized resource control in a command where resource constraints and geographic dispersion create special problems.

To compensate for short tours of duty and a lack of MCA expertise, special emphasis is placed on educating facility users and program managers. They are the ones who must be able to explain why their project is a prudent investment.

This is accomplished through frequent-user Area Facility Engi-

Aged "silver bullet" quonset huts like this one are making way for new barracks throughout Korea.

neer meetings and formal major subordinate command (MSC) briefings conducted throughout Korea.

We ask FEAK program managers and master planners to:

- Monitor the current status of each project.
- Produce complete project development brochures.
- Submit absolutely meticulous, complete DD Forms 1391.
- Justify projects thoroughly.
- Explain the consequences if a project isn't built.

Perhaps the single most important EUSA structure is the MCA programming model developed in 1982-1983. This simple model ensures that the most essential construction receives the highest priority.

Internal discipline guarantees program success

Here's how EUSA evaluates and disciplines its own planning to fulfill its master plans for a revitalized physical plant. EUSA-level review is a four-step process.

The MCA Programming Model

Group A

Project supports-

- Force structure increases
- Force modernization
- Force realignment
- USFK/EUSA command and control requirements

Group B

Project supports-

- Facility replacement
- Facility improvement

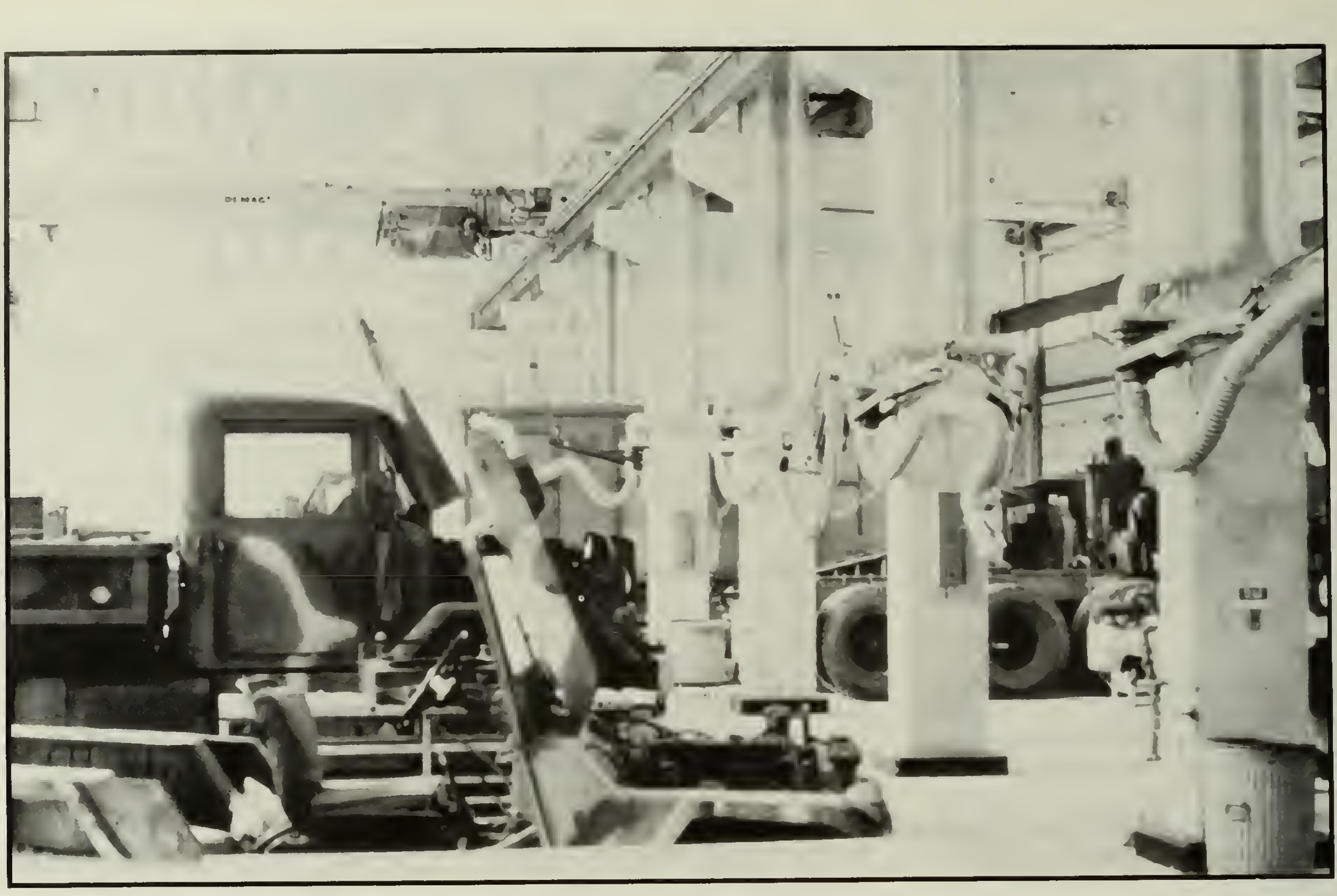
Priority order for constructing facilities

1 Unaccompanied personnel housing (UPH) and dining
2 Maintenance
3 Utilities
4 Training and administration
5 Supply and storage
6 Morale, welfare and recreation

Programming rules:

- Group A projects have priority over Group B.
- Priority order for constructing facilities is the same in both Group A and Group B.
- Any type of facility can be considered to balance a construction program if available funds will also cover Group A projects and barracks construction.

High-quality military equipment is now housed in high-quality facilities, thanks to an aggressive construction program.



Excellent maintenance is easier to achieve when soldiers can work in spacious, well-lit, well-equipped buildings.

The first step is an internal review by MCA project managers at FEAK. As project DD Forms 1391 are submitted, the responsible project manager reviews them for validity, content, and completeness.

They ask these questions: Is administrative data complete? Is the project justified? Is an impact assessment and economic analysis provided? Are utilities, communications, and demolitions costs and data provided?

Some common errors found during the review are:

- The requirements data or the unit cost for similar projects differ without explanation.
- The programmed amount (PA) for the project wasn't adjusted when the project was reprogrammed into a different fiscal year.
- The economic analysis is incomplete.

The second step is to consolidate the project management reviews. At a project review board, each FEAK project manager presents his projections to the FEAK MCA branch for critique and review.

Thus, six disinterested experts get involved in the justification process, and the project managers quickly gain familiarity with all aspects of each project. This pays big dividends during future reviews.

The third step is review by the Corps of Engineers Far East District. The district evaluates critical aspects of each project: project siting and existing ground conditions, costs, and justifications.

The district ensures all topographic conditions have been adequately considered in developing project costs. It conducts a complete analysis and verification of project costs and reviews the data to ensure that the basis for developing design criteria is complete.

The fourth and final step is a project evaluation by the EUSA Project Review Board, a clone of the infamous DA and DOD MCA murder boards. If a project can't pass the scrutiny of the EUSA board, it certainly won't make it past the DA board.

The EUSA format is almost identical to the DA board with each major subordinate command presenting a 30- to 90-second illustrated description of each proposed project.

Those who present projects prepare to answer the toughest questions the board can throw. They also prepare to answer typical questions that DA, DOD, and Congress have asked about similar projects in the past.

Here are some of the lessons learned that have helped shape EUSA's preparation process:

Selling a phased project. It often makes sense to phase large projects over 2 or 3 years. But this must be done carefully or the user risks the possibility that some phases won't be authorized. All project documentation must make it clear that each phase is essential to the whole.

Inadequate documentation cost EUSA an FY88 project that was an essential complement to an FY87 project. DOD thought the two projects were duplicates, and cut the FY88 half.

Making the costs clear. Cost estimating must be accurate. In the past we didn't worry. If the project amount was exceeded, more money was found. Now, overspending kills. Make sure all project costs are identified and included. Since communications and physical security costs often go undocumented, EUSA requires that the provost marshal and communications experts review all proposals.

Economic analysis should be part of every project justification. Never say an economic analysis is unnecessary. Instead, describe the alternatives to your proposal and explain why the alternatives are unacceptable.

Selling with photos. Only good pictures are worth a thousand words. Those that don't clearly illustrate the problem cause confusion and jeapordize your cause. If the briefer says, "You can't really see it but the whole wall is cracked. . ." or "That's actually water stained. . ." then he might as well throw the pictures away. Any photo that has to be explained doesn't do the project justice.

Show new facilities like fitness centers and dining halls in full use. Empty facilities invite speculation over whether or not they were needed.

Show pictures of substandard facilities that make a compelling argument. But avoid anything that looks staged or theatrical. Select photos and slides that depict the facts accurately. If it takes extra time and a professional photographer to get the right shots, do it.

Briefing VIPs. Visits from congressional delegations can be a tremendous asset. View them as an opportunity, but make sure they get all the facts an outsider needs to quickly understand why your projects must be built.

Remember that literally thousands of issues besides military construction compete for their attention. They don't have long to form an impression and make up their minds. Time and clarity are of the essence.

They must leave confident that you know what you're doing and with no doubts that your project is a sound investment. Any hint of conflicting facts or opinions from those they meet spells doom.

A recent visit by members of the House Appropriations Committee Surveys and Investigations team is a case in point. Before they arrived, they requested information on numerous topics. FEAK prepared a thorough briefing covering all aspects of the Real Properties Maintenance Activities program. We made sure every question was addressed. Team members complimented the quality and comprehensiveness of the presentation and the accompanying documentation. We are convinced that our efforts will pay dividends as they comment on the EUSA program.

Striving for perfection. Finally, projects cannot be "over reviewed." Detailed reviews by commanders, staff, and technical experts alike are essential.

Project Review Boards are the culmination of user involvement in our MCA programming process. They allow the commanders from the major subordinate commands to see the work effort and detail necessary to document and gain approval for their projects. Exhaustive review is a cornerstone of our MCA programming cycle.

The EUSA MCA program is a success because we identify our needs and explain them clearly. But these needs are only translated into tangible facilities through the dedicated efforts of hundreds of professionals in EUSA, FED and OCE.

EUSA's greatest satisfaction is the knowledge that we, as engineers, responded to the 2ID's PFC Warrior Challenge: "What have you done for him today?" The echo, "Plenty, thanks," resounds from hundreds of solid walls.

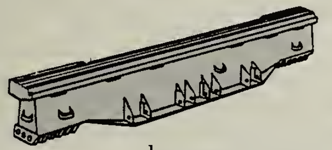
COL Carl O. Magnell is the Assistant Chief of Staff, Engineer, USFK /EUSA. His prior DEH experience includes 2 years as commander of Facilities Engineer Activities, Korea.

LTC Robert E. Jallette is Director of Plans, Programs, and Project Management for FEAK. His prior programming experience includes one year in the program division of the directorate of civil works HQ, USACE.

Engineer Problem

Name the component and identify the set

by CPT Steven W. Chandler



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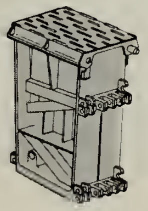

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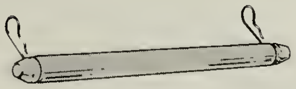

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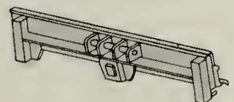

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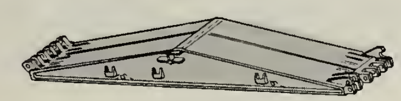

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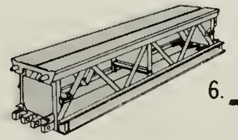

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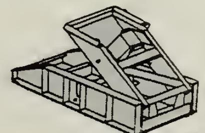

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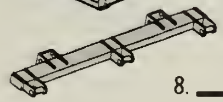

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Army Installation Engineering and Housing

The harsh Valley Forge winter of 1777 tested our soldiers' resourcefulness and willingness to sacrifice. While the winds howled and the snows flew, General Washington's men built huts, covered windows with oiled paper, cut fire wood, and laid out streets in their temporary garrison. Camp sanitation was almost unknown and huts were crowded beyond belief. Those soldiers' ingenuity in the face of hardship more than 200 years ago marked the infancy of the Army's struggle to provide facilities for its troops.

In garrisons established after the Revolution, and all through the 19th century, operation and maintenance of these garrisons was as varied as the men who performed the tasks. Until World War II, facility maintenance was regarded primarily as a housekeeping function--not as an Army mission. At each installation, the utility officer managed repairs and utilities (R & U) for the post quartermaster.

Maintenance and repair suffered after World War I--"the war to end all wars"--largely because the nation questioned the need for a standing Army in the new era of peace, and the Army was plagued with financial and personnel shortages.

When the United States entered World War II, tanks, bombers, and aircraft carriers had transformed combat. Clearly, the military needed reliable, modern facilities and utility services capable of supporting the advanced technologies of the 20th century. The Army sought a more structured, responsive approach to facilities maintenance and repair.

In December 1941, the responsibility for installation R & U transferred from the Quartermaster General to the Chief of Engineers, and a stovepipe engineer structure came into being.

The post utilities engineer--the title was made plural to denote increased responsibilities--reported to the Corps of Engineers' area engineer, then to the Corps' district and division engineers, who in turn reported to the Chief of Engineers.

The chain of command was streamlined 4 months later when the area and district engineers were removed from the chain of command. The senior engineer officer concerned with R & U became the post engineer. He reported directly to the division engineer who provided him with staff supervision and resources.

The post engineer served on the post commander's staff and worked for the first time in direct support of the commander. That relationship has continued to this day--although there have been shifts in how the Army assigned staff responsibility for management policy, resources, and supply support.

Within a few months functional responsibility was passed to the service command--an arm of "services and supply" in Washington D.C. The Chief of Engineers retained staff supervision and funding control until the 1950s when his influence over facilities repair and maintenance began to erode. In 1958, the Chief's responsibility was virtually eliminated when the Army Command Management System was created and R & U funding ceased to be separately identified at HQDA.

During the years of the Vietnam conflict, funds for real property maintenance and repair dried up, and the Army's aging facilities and utilities in the United States and abroad rapidly deteriorated. Dismay over the Army's growing backlog of maintenance and repair led DOD to establish a maintenance council. A series of studies were ordered to improve control of real property management with an eye to work management and productivity.

In 1968, the Army published the results of the Seeman Study, "Military Engineering in Support of the U.S. Army 1967-75." The study recommended that DA staff responsibility for real property maintenance (RPMA) be given back to the Chief of Engineers and that personnel assignments be upgraded. The controversial conclusions led the Army Chief of Staff to call for a more comprehensive analysis of RPMA.

The result was the 1968 Lincoln Study of "Total Management of Real Property Maintenance Activities." Its conclusions marked a turning point in professionalizing RPMA management.

The study said the RPMA mission was too fragmented and not adequately represented at HQDA. Technical supervision of the post engineer was inadequate and the post engineer himself was relegated to a too subordinate position on the installation staff. The study also concluded that the post engineer was ill-prepared for his job because he was given neither the experience, education, nor military training necessary to meet his responsibilities. Engineer officers had come to view facilities engineering as a dead end.

With regard to programming and budget channels, the Lincoln Study concluded that the existing system, which incorporates RPMA as an integral part of the Army Command Management System, served the Army best. This conclusion was fundamental--governing all other considerations in the study.

Important organizational changes ensued in the 10-year period following the report. The Chief of Engineers became RPMA Program Director. A Directorate of Facilities Engineering was established in the Office of the Chief of Engineers. There was a quantum leap in the technical support provided to post engineers by their district engineers. The post engineer position was raised to the directorate level at most installations.

Family housing first became an engineer concern in 1963 when functional responsibility was transferred from the Deputy Chief of Staff, Logistics (DCSLOG) to the Office of the Chief of Engineers. Installations followed the HQDA move by assigning family housing to the post engineer, who by then was called the facilities engineer.

In 1968, family housing supervision seesawed back under the DCSLOG, and most installations transferred the housing office to the logistics manager. It shifted again in 1974 back to the Office of the Chief of Engineers, where it remains. The field followed more slowly this time, but by the early 1980s the facilities engineers had changed their names to Directorates of Engineering and Housing to denote their new housing responsibilities.

Thus, the DEH as we know it today was born.

In 1977, the Chief of Engineers decided it was time to assess how far RPMA management had come since the Lincoln Study. He ordered a study of the entire RPMA system in two phases.

The first, which was conducted in-house, was limited to recommendations that could be accomplished within the existing organizational and command structure. The second, which was done by contract, was designed to give an unconstrained assessment of an optimum RPMA organization

The first phase concluded that RPMA under the Army Command Management structure should be more intensively managed at HQDA and the major commands. The report again focused the Army's attention on the growing complexity and importance of RPMA.

The second phase, prepared by Lester B. Knight & Associates, Inc., suggested that DEHs be consolidated with Corps of Engineers field organizations to provide RPMA services to installations on a reimbursible basis, using a revolving fund. The MACOMs and installations would continue to identify requirements, set priorities and program and budget appropriate funds. The Corps' divisions and districts would provide management planning, engineering, technical, and contract support.

The Vice Chief of Staff of the Army gave concept approval for a development plan for the Chief of Engineers to assume RPMA responsibility CONUS-wide. A test consolidation was approved in the National Capital Area. The U.S. Army Engineer Activity, Capital Area, was formed as a Corps field operating agency in 1980 to operate RPMA support for eight installations in the Washington, D. C. area.

During the 1980s, HQDA and Congress recognized that the Army's huge backlog of maintenance and repair on antiquated facilities had gone without major renovation since World War II.

Thanks in large part to the vociferous concern of soldiers and their Commanders, Congress provided funds for a renaissance in facilities modernization and construction aimed at getting soldiers and equipment out of the mud.

The volunteer Army--with its emphasis on encouraging good soldiers and their families to choose Army life as a career--has also increased emphasis on improved barracks, family housing, and morale, recreation and welfare facilities to improve quality of life.

With the boom in new construction and major renovation, installation DEHs turned increasingly to their supporting Corps districts for design and contracting support. In 1985, the Chief of Engineers issued the Green Ribbon report which evaluated the U.S. Army Corps of Engineers' support to installations and recommended improvements in several areas.

These included the cost of doing business; responsiveness and efficiency; USACE installation support priorities and policies; DEH education, training, and career development; procurement support and commercial activities; and the scope and nature of USACE support. Implementation is ongoing.

The commercial activities program--the federal government's effort to contract services that the private sector provides more economically--has also been a major force in the DEH business during the 1980s. By 1985, contracts accounted for 85 percent of all custodial services, 69 percent of all refuse collection, 69 percent of all utilities operation and maintenance, 67 percent of all building maintenance and repair, 42 percent of all grounds maintenance and repair, and 38 percent of all pest control. Over all, contract expenditures account for about 60 percent of total RPMA.

Today there are two standard DEH organizations: one for predominantly in-house maintenance and repair operations, and one for installations where RPMA services are handled primarily by contract.

Facilities and housing management have become big business since World War II--employing thousands of people and accounting for billions of defense dollars. Today, no other organization affects the living and working conditions of an installation more dramatically than the DEH.

DEHs must continue to draw on the lessons of the past as installation management mission evolves to meet the challenges of a new decade.

Mr. Joseph W. Whitaker is the Chief of the Construction Programming Branch in the office of the Assistant Chief of Engineers. He is also former chief of the RPMA Management Branch. He holds a BS in industrial engineering from the Georgia Institute of Technology, and MBA and MPA degrees. He is a registered professional engineer in Virginia.

The Facilities Technology Applications Test Program—Tapping the state of the art

by Dr. Donald J. Leverenz and Bernard S. Wasserman

The Army owns over 190,000 buildings and facilities worldwide. Over 42 percent are more than 35 years old. Quality facilities require an extensive maintenance and repair program. Yet even the $1.9 billion spent in 1986 still left a backlog of over $1.2 billion. New engineering technologies offer excellent ways to stretch the budget. But how does the Army know which are winners, and how does the DEH find out about them?

The Corps of Engineers started the Facilities Technology Applications Test (FTAT) Program in 1984 to take technology out of the lab and show the cost savings that can be achieved.

A committee of engineers from the U. S. Army Engineering and Housing Support Center and the Army MACOMs selects technologies that have shown promise in industry or the Corps labs' research and development programs.

Candidates are chosen from four areas:

- Building maintenance and repair.
- Energy conservation.
- Pavement and railroad maintenance and repair.
- Environmental improvements.

The Corps' research and development labs manage the demonstrations based on their areas of expertise:

- The Construction Engineering Research Laboratory (CERL).
- The Waterways Experiment Station (WES).
- The Cold Regions Research Engineering Laboratory (CRREL).

Installations with maintenance and repair problems that are good candidates for the technology are chosen as test sites. The labs share the test results and lessons learned with other interested DEHs.

Many installations are already enjoying benefits and savings. More than 90 demonstrations of 52 technologies are completed or under way. A sampling of FTAT projects follows.

Building maintenance and repair

Cracks and spalls in concrete water towers and buildings at Fort Bragg were repaired with a ***latex-modified concrete and epoxy resin.*** This technique saved $50,000 compared to the standard practice of removing and replacing damaged concrete.

A ***ceramic anode*** developed by CERL is a major breakthrough in the Army's battle against corrosion. Cathodic protection systems using the anode have been installed on water tanks at Fort Ord and on underground piping systems at Fort Monroe. The anode, which prevents rust, extends the life of steel structures and lowers life cycle maintenance costs.

The Naval Civil Engineering Research Lab and CERL developed ***paint test inspection kits.*** The kits were distributed to more than 100 Army installations. They help determine whether a paint meets specifications. It is a screening device for identifying whether paint samples are suspect and should be tested by a qualified lab.

Aerial surveys were used to inspect roofs at Forts Wainwright, Greely, Richardson, and Detrick. Infrared scanners, mounted on a helicopter, quickly identify wet insulation. All roof membranes at large installations can be surveyed in a few hours. Walking each roof can take weeks.

Energy conservation

An energy ***retrofit package*** for barracks, dining facilities, and motor pool repair shops is being demonstrated at Fort Carson. The package includes a number of conservation options such as smaller windows, exterior insulation, mechanical systems retrofit, insulated partitions between office and shop areas, and heat recovery systems.

CERL developed retrofit packages for four standard types of Army buildings—two for barracks, one for a dining facility, and one for a motor pool repair shop. Preliminary data from Fort Carson indicates the retrofits will result in significant savings.

Pulse combustion and condensing hot water boilers are being demonstrated at Fort Knox and Fort Campbell. These high-efficiency heating systems are being considered for small office buildings, barracks, or support facilities—not for central heating systems. Annual efficiencies for the new systems are in the 80- to 90-percent range compared to 50 to 60 percent for the old existing gas heating systems.

The Fort Stewart post exchange demonstrated use of a ***diurnal ice storage system*** to offset the high cost of operating conventional air conditioning during daytime hours. The system uses off-peak electricity during the night to make ice that is used to cool the air during the day. This reduces both the demand charge for electricity and the size of the chiller the building requires.

Efforts to reduce corrosion and heat loss in ***underground heat distribution systems*** are under way at Fort Jackson. Over 20,000 feet of prefabricated steel conduit and 9,000 feet of shallow trench distribution system have been installed. Improved design and maintenance procedures should save energy and extend the life of these systems.

High-tech can mean low cost: here, a modified asphalt distributor stabilizes airstrip surfaces, doubling operability for 20 cents a square yard.

Pavement and rail repair

A new machine that ***reheats asphalt*** on the spot to repair potholes was demonstrated at seven installations—including several in Korea. The demonstrations showed proper techniques for preparing potholes before applying the heated asphalt. Conventional pothole patching costs approximately $300 per ton—compared to $60 per ton for recycled asphalt.

Dust clouds on unsurfaced roads and pavements pose both safety hazards and maintenance problems. At Fort Chaffee, a ***modified asphalt distributor*** was used to spread 30,000 gallons of magnesium chloride solution on an assault runway. It cost 20 cents a square yard, and airstrip operations improved 100 percent. The 30- to 40-minute intervals between takeoffs and landings were reduced to 15 minutes. At Fort Bliss, dustproofing on tank trails reduced the need for blading operations by 25 percent.

When water enters soils that support ***railroad tracks,*** operational and maintenance problems result. At Red River Army Depot, a hot-mix asphalt layer was placed over compacted subgrade. The asphalt concrete layer strengthened the total track structure, which should significantly reduce maintenance requirements for 20 years.

Environmental quality

Foul odors, unclean conditions, and groundwater contamination are often problems at remote training sites. At Fort Jackson, problems were solved by installing ten ***composting latrines*** at two training ranges. A series of air channels, baffles, and low-wattage fans enhance the aerobic breakdown. No water or chemicals are needed.

At Fort Stewart, five ***vault latrines*** were retrofitted with bubble aerators that consist of a blower unit and a perforated pipe. The air helps grow organisms that break down the waste. TRADOC now requires that these technologies be considered at future remote sites.

At Fort Carson, *revegetation techniques,* using native plant species, successfully restored an 80-acre swath of severely damaged land. The installation developed a three-step approach for maintaining military training sites that consists of—

- Revegetating severely damaged areas.
- Developing criteria for selectively resting damaged areas.
- Conducting an awareness campaign for trainees.

For more information on the FTAT program, contact USACERL, Dr. Robert Dinnat, P.O. Box 4005, Champaign, IL, 61820-1305, phone: (217) 352-6511; or Jeffrey Walaszek, phone: (217) 373-7216.

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Bernard S. Wasserman is a mechanical engineer in the Utilities Branch of the Facilities Engineering Division, Office of the Assistant Chief of Engineers. He is chairman of the steering committee for energy technologies for FTAT. Mr. Wasserman holds a BS in mechanical engineering from New York University.

Troop Construction Programming—A useful resource for the DEH

by LTC Charles R. Meyer and Louis Douglas Turney

For the past 4 years, the 18th Engineer Brigade, headquartered in Karlsruhe, Germany, has proved to be the perfect partner for the local Directorate of Engineering and Housing (DEH)—providing troop construction to improve living and working conditions for soldiers and their families.

Together, the Karlsruhe DEH and the 18th Brigade have completed more than $6 million worth of repair, maintenance, and minor construction projects at half the cost of comparable civilian contractors.

Troop construction labor costs are about 25 to 50 percent lower than the cost of equivalent work performed by civilian engineering contractors. Design costs are about 50 percent lower than fees charged by civilian architect and engineering design firms.

These cost advantages are coupled with an aggressive inspection and warranty program, administered by the brigade.

All these programs assure project accountability, which is often costly and difficult to ensure with civilian contractors.

Thus, the brigade gives the USAREUR DEH a flexible design and construction agency that substantially supplements existing assets at a very reasonable cost.

The disadvantages can be concisely summarized. They are the time

Troop construction labor can build new facilities—and cut costs in half.

and money costs of supply and troop logistics support.

The DEH is responsible for supply support and must order project materials well in advance of project start dates (3 months for small projects, 6 months for large projects). All materials must be ready when the troops are available, and supplies must be securely stored for the duration of the project.

If troops are not permanently stationed at the installation, adequate billets and mess facilities must be provided. Otherwise, temporary duty costs can wipe out the project savings.

Here's a sampling of what the 18th has accomplished:

- The 697th Civilian Services Group (CSG) completely renovated (interior/exterior) a 112,000-square-foot administration and billeting building at Rhineland Kaserne for $1.5 million.
- The 293d Engineer Battalion repaved all asphalt streets and parking areas at the Karlsruhe shopping center for $150,000.
- The 79th and 293d Engineer Battalions repaired the drainage system, and resurfaced and rebuilt hardstand areas at the air field for $180,000.
- The 697th CSG repaired all perimeter and motor pool fence lines (28,000 linear feet) in two kasernes for $400,000.

If these projects had been done by a civilian engineer contractor, the work would have cost nearly $4 million. The 18th did the work for $2.3 million.

The 18th has also undertaken a number of smaller projects to improve quality of life for soldiers and their families stationed in Karlsruhe, including—

- New dugouts for the ballfields.
- Sidewalk network for a family housing area.
- BMX bicycle track for a youth activities center.
- Community thrift shop.

Assets of the 18th Engineer Brigade

The 18th Engineer Brigade is 4,300 strong—comprised of four engineer battalions, one topographic battalion, and a civilian services group (CSG). The brigade maintains combat readiness and manages and executes the Headquarters USAREUR and the 7th Army Troop Construction Program.

The CSG units consist of numerous highly skilled European civilian craftsmen (masons, electricians, carpenters, plumbers) who are permanently assigned to the brigade. They do exceptional quality interior and exterior building and renovation work, as well as minor construction.

The military engineer units consist of soldiers whose work is a combination of MOS training and craftsmanship. Minor repair and construction projects that help them hone readiness skills are ideal. These projects involve repaving asphalt services, installing concrete foundations, or erecting prefabricated structures.

Both groups do quality work, but the DEH should keep in mind the experience factor when choosing troop construction projects. The CSG craftsmen are trained and experienced, while many of the soldiers are being trained to proficiency in their MOS. The soldiers also rotate every 2 to 3 years while the CSG work force remains fairly constant.

The DEH's commitment to working with the brigade is vital. Karlsruhe established an operations office that manages and coordinates troop construction. The office, which is staffed with an engineer officer and three NCOs, serves a manpower mission authorized by Army Regulation 5-3.

The office initiates all work order requests (detailed scope of work, site plan, current working cost estimate, and project point of contact). The staff orders the bill of materials and supplies, and makes troop billeting arrangements.

Staffers also work with the brigade, inspecting all projects on a daily basis and ensuring warranty work is performed.

Any USAREUR DEH can tap the resources of the 18th Brigade. Projects should be submitted for consideration at least a year before the desired completion date.

The Headquarters USAREUR Construction Review Committee (CRC) prioritizes and approves the 18th construction schedule. New project proposals are generally solicited each year in February, prioritized in March, and approved in April. The committee holds a midyear review in November. Although the USAREUR CRC only meets twice a year, the 18th considers additional projects as assets become available.

The harmonious relationship between the Karlsruhe DEH and the 18th Engineer Brigade truly illustrates how the Base Operating Information System (BASOPS) mission can be effectively supplemented with an aggressive troop construction program.

LTC Charles R. Meyer has served as Karlsruhe DEH, and with VII Corps in Stuttgart, Germany; he has also served with the 7th Infantry Division and as Engineer Staff Officer to the Combat Developments Command at Fort Ord, California. He is a graduate of USMA and holds an MS in mechanical engineering from the University of California.

Louis Douglas Turney has served as Deputy DEH in Karlsruhe and Goeppingen, Germany, and as Chief, Utilities, Energy and Environment, Aschaffenburg, Germany. He has a BS from the University of Arkansas and an MS in Civil Engineering from the University of Oklahoma.

Computer assisted design and drafting

The payoff for maintenance and repair

by B. Ray Summerell

Imagine trying to work a jigsaw puzzle without the picture. That's what maintenance and repair management has been like for Army facilities engineers. We have tons of maps, as-builts, building footprints, and historical data files, but no way to sort, update, or cross-reference them. These information tidbits are scattered throughout the DEH like so many puzzle pieces—impossible to assemble and use.

So managers work hit or miss, relying on memory and the relatively few maps and files they manage to piece together. Yet they know how much more effective they would be if they could study the whole picture.

Now Computer Assisted Design and Drafting (CADD) can provide that picture. Although CADD is best known for its applications in design, drafting, and engineering, TRADOC believes the biggest payoff will be for DEH real property maintenance and facilities management.

CADD's Automated Mapping/Facilities Management (AM/FM) data bases can consolidate an installation's engineering records and put them at the DEH's fingertips, where they can be used to help diagnose problems, determine the scope of work, and get the right people and equipment to the right place at the right time.

The AM/FM data bases will store base maps, as-builts, building footprints, street and utility grids, site plans, and other engineering technical data in ways that make reams of tabular data readily available to facilities engineers. Each graphics data base is linked with an interactive attribute file where corresponding historical data and other technical information is stored. A CADD work station lets engineers view the maps and corresponding tabular data simultaneously.

City and state governments, public utilities, telecommunications companies, and large industrial complexes are all looking at CADD as a way to simplify daily operations. The Army must do likewise. The AM/FM data bases satisfy the DEH's needs. There is no need to undertake expensive research and development to create a unique system for the Army.

Think of AM/FM as a set of map overlays that include, for example, information on every building, street, parking lot, generator, manhole, cable, power pole, length of pipe, and fire hydrant on post—plus all the vital background and statistics a facilities engineer needs to make sound maintenance and repair decisions.

At the push of a button, engineers can study utilities for an entire housing area or just one building. They can look at the whole utility system or zero in on one section of pipe.

CADD-based maps can be overlaid so they show the relationships between systems. For example, if the water line in a housing area is leaking, it is easy to call up the utility system map on the computer screen, place the cursor over the troublesome section of pipe and ask

A DEH CADD "kit" will soon be available from the U.S. Army Construction Research Laboratory (CERL) to help interested DEHs assess their organizations' unique automated graphics software and hardware requirements. The CERL is also working closely with the Chief of Engineers' Office, USACE, FESA, and MACOM engineers on an automated graphics/CADD implementation plan and pilot test to "fine tune" requirements, select and acquire an appropriate system, coordinate IFS-M data/system integration, and efficiently manage the system once in place.

The CERL's principal investigator and point of contact for CADD/AM/FM is Michael T. McCulley, who can be reached at 1-800-USA-CERL (extension 728) or FTS 957-7728.

The DEHs may also want to consider joining the AM/FM International Professional Society—a user's group composed of city governments, utilities, and DOD agencies who are pursuing CADD. For information, write: 775 E. Orchard Road, Suite 820, Englewood, Colorado 80111.

the computer to display the corresponding tabular data.

Within seconds, the computer provides a closeup schematic of the pipe with all the information necessary to decide what type of materials to send to the job site and whether a patch job or a major repair is required. The information might include—

Pipe size.
Flow.
Age.
Depth.
Type of pipe.
Date and type of last repair.
Date of next scheduled maintenance.
Date of last pressure test.

Computer overlays of adjacent utilities make it easy to see whether workers are likely to cut a neighboring phone or electric line, which would accidentally disrupt service and make a bad situation worse. If AM/FM shows that phone cable is buried adjacent to the water pipe, the work order section can notify the repair crew that they should plan to leave the backhoe behind and dig the line by hand.

AM/FM can provide a sketch of the area and the pertinent details. The repair crew annotates the sketch with its changes, and the work order section can use it to update the data base.

There are three obstacles to expeditious implementation of CADD for installation DEHs:

- The start-up costs are high—although TRADOC believes a payback of 3 years is not beyond the realm of possibility—and the Army currently has no funds programmed to support CADD buys for installations Armywide.
- As with all automated systems, the break-in period is painful. The DEH's responsiveness suffers in the short run, while the staff is trained and operating procedures are revised to take advantage of the new system.
- There are no Army standards regarding staff impacts or the cost/benefit analysis for implementing AM/FM. This can complicate commercial activities studies, which tend to look at the DEH as it has been—making it difficult to introduce new systems and make the necessary staff adjustments.

Despite these obstacles, TRADOC is committed to CADD as the resource management tool that will revolutionize the maintenance and repair business in the years ahead. Currently the command is centrally funding and managing a program to introduce CADD at six installations.

Architect/engineer firms are updating engineering records and preparing AM/FM data bases for Forts Benning, Benjamin Harrison, Jackson, Monroe, Sill, and Leonard Wood.

The basic cost for an AM/FM data base is $600,000 or more—depending on the installation size, development density, training costs and the need for assistance in developing applications.

The payback period—based solely on maintaining master plans and graphics records in accordance with existing regulations—is 8 to 10 years.

This doesn't take improved DEH operations into account. TRADOC estimates that cost avoidance for maintenance activities will easily top $400,000 per year for labor, vehicles, equipment, and materials. If so, payback within 3 years is possible.

But the most important CADD benefit is intangible—the opportunity to be more responsive to customers. Facilities management decisions must be made quickly and efficiently in peacetime. During a mobilization effort, speed and quality are even more essential. AM/FM data bases have a vital role to play in the facilities engineer's readiness for either challenge.

B. Ray Summerell currently manages the CADD and AM/FM programs for the Deputy Chief of Staff, Engineering, at TRADOC, Fort Monroe, Virginia. He is also the proponent for long-range planning and related facilities management work throughout TRADOC. He has been involved with Army engineers' use of CADD and AM/FM for more than 10 years.

Physical Fitness:

by CPT Thomas A. Wuchte

The blood is pounding in your head . . . your lungs are seared with each breath . . . the crunch, crunching of your running shoes against the cinder track quickens as your burning eyes lock on the finish line.

Crossing the line, you gasp with relief because you know that you have passed, even if barely, another Army Physical Fitness Test (APFT).

But is "barely passing" the goal of the Army's physical fitness program?

All too often, soldiers associate fitness with passing the biannual test. Passing the APFT meets the minimum level of fitness to serve in the Army. The goal of the Army is for commanders and supervisors to ensure that the highest levels of fitness are achieved, both for themselves and for their subordinates.

Attaining a high degree of fitness requires an adequate program and individual commitment.

Before assessing the Army's physical conditioning program, we have to define fitness. Several factors are involved in assessing fitness; however, for simplicity, only muscular strength and aerobic ability will be considered here. Aerobic fitness is measured by VO_2 max capacity. VO_2 max is the limit of the muscles' ability to absorb oxygen from the bloodstream. Muscular strength is best described as the maximal force which can be generated in a single concentrated effort, often judged by one's ability to exercise using one's own body weight.

If you attain relative strength development and corresponding cardiovascular fitness, you will feel better, work longer, and ultimately be more productive. Studies have shown that fitness-oriented workers are more enthusiastic about work. An aerobic program also decreases the number of breaks workers take and increases their work rate. Couldn't everyone benefit from increased levels of individual fitness?

The current combination of sit-ups, push-ups, and the 2-mile run serves as the Army's basis for measuring physical fitness. Push-ups evaluate the strength of the chest, shoulders, and triceps, while sit-ups measure abdominal and hip-flexor muscles. Although neither provide a direct measurement of the single concentrated effort associated with muscular strength, they serve as excellent motivators and indicators for training.

A recent study concluded that there is a high correlation between 2-mile-run times and the ability to attain VO_2 max. Unfortunately, few soldiers run 2 miles in a time likely to achieve VO_2 max. Since cardiovascular endurance is the most significant factor of total fitness, one must question whether poor performance is a result of poor fitness, poor motivation, or both.

The answer is both. Although no study conclusively states what an average person can achieve for a 2-mile-run time, a 14-minute time is consistent with excellent aerobic conditioning. Therefore, any soldier under age 30, who runs three times a week at his training heart rate, should be striving for this goal. Similar fitness levels can be achieved by reaching training heart rate through swimming, biking, or other high-level cardiovascular exercises. Certainly, 14 minutes is not a time every soldier can achieve, but 17 minutes 18 seconds (the minimum time for a 30-year-old male) does not challenge him to meet his VO_2 max potential.

Unfortunately, understanding of the importance of fitness varies, and the principles of fitness are not universally applied by all leaders. Education to standardize this understanding is taking place. For instance, the first 2 weeks of the Engineer Officer Advanced Course (EAOC) include several days of classroom and practical exercises on fitness. This state-of-the-art training encompasses nutrition, diet, weight control, flexibility, muscular development, and cardiovascular improvement. The validity of effective exercise could not be presented better.

The EOAC instructors teach the aerobic concept of fitness through achieving the training heart rate. Achieving a training heart rate (70 percent of the maximum heart rate) for 20 minutes three to four times per week will improve an individual's aerobic fitness. This is where many fitness programs fall apart: they do not achieve the training heart rate for more than a few individuals. Moreover, most people are incapable of working to this level because they do not know how to achieve it. The standard 3- to 5-mile formation run, three times a week, rarely exceeds 8 minutes per mile. Only the most out-of-shape person will benefit from it. Alternatives such as circuit training, small compatible-ability group runs, and fartlek (short-burst, pace-varied running) training are much better suited to achieving a training heart rate for a variety of individuals.

To further disseminate newly developed fitness methods, the Master Fitness Trainer Course was developed. Here the Army has created a program to train at least one qualified officer or noncommissioned officer to implement the concept of total fitness at the battalion level. Once master fitness trainers are incorporated into unit physical training

Are we providing adequate emphasis?

programs, improvements in fitness levels are usually seen in short periods of time.

When officers attend the EOAC, their APFT scores figure into their overall academic average and the Academic Efficiency Report. As expected, motivation to do well on the test is correspondingly high. The APFT's weight on both officer efficiency reports (OERs) and enlisted efficiency reports (EERs) promotes a pass/fail attitude with no relative benefit for superior performance. Linking APFT scores more closely with career advancement (in bracketed increments such as are associated with E-5 and E-6 Board scores) will increase soldiers' motivation to perform to their potential both in training and on the test.

Another positive step would be to make some tests unannounced and have them administered by a disinterested party. It is a rare commander who will observe a soldier fail, and then not give him a few weeks to improve. The EOAC offers a perfect example. An impartial diagnostic test is administered in the first week to indicate where students may require improvement. In a recent cycle, 15 of 58 officers failed this test. There was no reason why this should have been only a diagnostic test, especially for the 10 active duty officers who failed. Soldiers should be fit all the time. Unannounced tests would promote 365-day-a-year, not biannual, fitness.

Since the APFT provides an accurate and adequate system to check fitness levels, linking it more closely to career advancement will make it a critical event. Adding unannounced tests stresses year-round fitness—the standard of readiness an army needs. If the Army wants maximum fitness, it must differentiate between those who strive to achieve the maximum and those who are satisfied with the minimum. The final product will be a better conditioned Army.

CPT Thomas A. Wuchte graduated from the United States Military Academy in 1982, where he competed in indoor and outdoor track, and cross country. During his senior year, he captained the cross country team. Following his graduation, he served in the West Point Athletic Department for 6 months recruiting cadet athletes. He has been assigned to the 293d Engineer Battalion in Baumholder, Germany, and is currently assigned as the training officer with the 7th Engineer Brigade in Kornwestheim, Germany.

Writer's Guidelines

Do you have an articles, photographs, or artwork to submit to **ENGINEER?** Here are some tips.

TOPIC: We focus on combat engineering; however, any articles of interest to engineers are welcome. Write in active voice and be as concise as possible. Please give your article a title, too.

LENGTH: Let your subject dictate length; generally, articles should be two to six pages, double spaced.

PHOTOGRAPHS AND ARTWORK: Besides photographs and artwork which supplement articles, photographers and artists should submit any work that may be of interest to engineers. Your photos should be 5 x 7 black and white, glossy. Please include a caption and photo credit. Drawings should be legible, but do not have to be camera ready.

DEPARTMENT: We are always looking for items for our departments:

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The Corps Overseas-Opportunities for Those Who Are Ready

WANTED: Adventurous engineer officers for exciting, career-enhancing assignments overseas. Language training necessary.

by BG C. E. Edgar, III

The Corps of Engineers' international program of military construction and nation-building becomes increasingly important with each passing year. Through the work of its European, Pacific Ocean, and South Atlantic Divisions, the Corps' international activities stretch all the way around the world. We need capable, adventurous, and language-trained engineer officers willing to try their hands at "real world" engineering—sometimes in harsh climates and under adverse living conditions.

The Corps has been doing development studies on some of the major rivers of the world: the Niger, the Orinoco, and the Yangtze. We've built small airfields in Honduras and $16 billion worth of military and port facilities in Saudi Arabia.

In my job as South Atlantic Division Engineer, I have responsibility for the Corps' international programs in Central America and the Caribbean Basin, Africa, the Middle East, and areas as far away as Burma.

From Puerto Rico to Oman, here are a few of the exciting projects of which you could be a part.

In Oman, Middle East/Africa Projects Office (MEAPO) has a $311-million military construction program to build air bases for the Omanis at Seeb, Muscat, Masirah, and Thumrait. These bases, which are being built for the defense of Oman, would be usable by U.S. forces with the permission of the Sultan. They are an important part of the U.S. defense strategy in the Middle East and a top-priority project of the U.S. Central Command.

The MEAPO is coordinating the design and construction of air base improvements at five sites in Egypt. Much of this work supports the sales of F-16 aircraft. We have requests for support from the Egyptian Navy and other government agencies, and look forward to an increasing workload over the next five years.

The MEAPO also has an international mission in support of the Voice of America, designing and/or building five new transmission towers in Morocco, Botswana, Thailand, Puerto Rico, and Sri Lanka.

In Africa, the Defense Department's Military Civic Action program is gaining momentum as the Corps provides technical assistance, supplies, equipment, and materials to emerging African nations. Projects ranging from an airfield upgrade in Niger to a hospital maternity wing in Senegal will help build these nations' infrastructures. They are designed to provide maximum participation by host-country military forces to improve their military engineering capabilities.

A 1,350-foot intake and diversion tunnel, Cerrillos Dam, Portugues and Bucana Project, Puerto Rico.

In our own hemisphere, South Atlantic Division has some of the most exciting work now going on anywhere in the Corps. Our Jacksonville District has for many years managed civil works design and construction in the Commonwealth of Puerto Rico. The district is currently working on the Portugues and Bucana River project, a challenging flood control and water supply project. Near Ponce, on the island's southern coast, the project involves constructing two dams, 7.6 miles of channel improvements, and a 1.1-mile-long diversion channel from the Portugues to the Bucana River.

The project presents many engineering and construction challenges. The Cerrillos Dam, on the Cerrillos River, is being built as an earth and rock-fill structure containing some four million cubic yards of fill. Preliminary to construction, the Corps is blasting a 1,350-foot-long intake and diversion tunnel through limestone and volcanic rock.

The other dam in the project, the Portugues Dam, is a challenge of a completely different type. It is a double-curvature, thin-arch concrete dam, the first of its type in Corps history. It will be only 40 feet wide at the base, as compared with a typical earth or rock fill-dam, which would be from 100 to 1,000 feet in width.

Also, in Puerto Rico we are meeting a less traditional challenge. The Puerto Rico Aqueduct and Sewer Authority (PRASA), under court-imposed deadlines to comply with the Clean Water Act, has asked the Corps to help them design, construct, operate, and maintain five new regional sewage plants. This project, just getting under way, is especially in need of aggressive and knowledgeable young engineers, preferably with a working knowledge of Spanish.

We also have challenging work elsewhere in Central America under the direction of the Mobile District, supporting friendly governments throughout the region. As the strategic importance of Central America grows, this part of the world promises many new opportunities.

The projects outlined here all present unique opportunites for engineers to gain broadening and career-enhancing field experience.

The only requirements are that you be willing to undertake the difficulties, and that you prepare yourself, particularly with language training. Engineers working in Puerto Rico on the PRASA work, for example, are required to work extensively with the Puerto Rican architect-engineer community, officials of PRASA, and a Puerto Rican technical and labor force. Fluency in Spanish is essential.

Language training is available from many sources, both inside and outside the Defense Department. One important training resource is the Defense Language Institute in Monterey, California. As its name implies, this DOD school provides formal language training in a variety of languages, from Spanish to Indonesian to Arabic. Other sources are also available, including private language institutes such as Berlitz.

Once language-qualified, you will have greater opportunities for the types of assignments I've been discussing here—leadership assignments on the cutting edge of Army engineering, as the Corps' overseas missions continue to thrive and grow.

"This is the best job I've had in the Army," says MAJ Sean Wachutka of his assignment as Mobile District's Area Engineer for El Salvador.

Wachutka sought out the assignment because, he says, "I was bored with my desk job in St. Louis." So, armed with a masters degree in civil engineering, some high school Spanish, and a facility for languages, he actively pursued the assignment to oversee the Corps' $16 million in foreign military sales work in El Salvador, as well as the construction of bridge piers to replace three key bridges destroyed by insurgents.

"I wanted to try something different," he says, "And I haven't had any regrets."

One of the most attractive things about the job, according to Wachutka, is its independence and opportunities for leadership. "Here, I'm the only U.S. Army engineer in-country. And when the ambassador, the MILGROUP leader, or the Air Force needs an engineer's advice, they call on me. In a job like this, there's no one looking over your shoulder, second-guessing your decisions.

"Things here are 'real time,' too," he says. "We're working on things these people really need, and need now. They're not just 'nice to have' items."

And assignments such as this one can lead to even more challenging missions.

Most recently held by LTC Stanley Phernambucq, the Jacksonville District's deputy district engineer for Puerto Rico is an exciting job as the number one engineer in the Commonwealth. The position demands independence and leadership ability.

Phernambucq previously had an overseas assignment in Brazil, and this experience along with a knowledge of Portuguese and Spanish gave him a real leg up.

"In this job you have everything—construction, diplomacy—working with military and civilian personnel," Phernambucq says. "We're building up here, and as the chief Corps engineer on the island, I'm ad-libbing . . . making on-the-spot decisions much of the time."

"The job is tough sometimes," he says, "particularly in a different culture. But nothing beats it."

Leadership assignments such as these offer those with the right qualifications—advanced education and language training—the opportunity to try 'something different,' while giving career-enhancing experience. In return, the Corps gains field-trained officers, and friendly nations gain expert engineer support.

MG C. E. Edgar, III is Commander and Division Engineer of the U.S. Army Corps of Engineers' South Atlantic Division. Prior to his current assignment, General Edgar was Acting Director of Civil Works in the Corps of Engineers' headquarters in Washington, D.C. A graduate of VMI, where he received a BS in civil engineering, he also holds an MS in civil engineering from Iowa State University of Science and Technology. He is a graduate of the U.S. Army Command and General Staff College and the U.S. Naval War College. He is a registered professional engineer in Kentucky and Alabama.

The Constitution: A commitment endures . . .

by Penelope Schmitt

Here in Washington, D.C., the public celebration of the Constitution's bicentennial was like a 4th of July on the mall--thousands of bright balloons floated upward; a child's voice sang "This Is My Country;" high school bands thumped and blared; we half-listened to speeches that were decidedly less memorable than the document they honored.

Finally, we gathered our thousands of voices in the pledge of allegiance. Right up to that thundering recitation, I had the detached eyes of a public affairs professional observing a made-for-TV phenomenon. It would have been nice, I thought, if the sky had made a bluer contrast to the balloons.

But then came the pledge--and the union of hopes and loyalties swelling in the sound of it made me feel a strong sense of the Constitution's presence with all of us. That fragile tissue connects us to our whole past--and to each other--in a structure that protects the basis of our lives, that gives us room for hope and change, and calls us to take responsibility to defend one another's freedoms.

By now, the festive balloons have all burst. The speeches are forgotten. The bands are practicing for a halftime show at the next football game. All over America, we pursue our trivial happinesses and our great dreams in security.

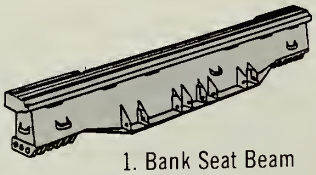
Most of us don't think of the Constitution often, and we will probably let the immediacy of the summer's observance fade soon. But the Constitution endures, and so does the work of those who dedicate their lives to preserving it and keeping it alive.

By day and by night, security officers at the National Archives protect the document. Supreme Court justices defend the integrity of its meaning. Teachers rehearse its content. Grade schoolers stand firm on it in a small way when they retort to an insult: "it's a free country!" Scholars and attorneys study and interpret it to meet the time and to serve living Americans. Victims of injustice turn to it for refuge. Congress, the federal courts and the President of the United States consult it as their guide for governing the nation. Seekers after perfection work to amend it.

And those of us who serve in the Armed Forces stand ready for the orders that may call us to defend the nation built on this document.

We don't always think about the Constitution--yet hundreds of thousands of us pledge our labors and our lives to support it every day. The hoopla is over--but the Constitution stays with us while we, the people, work to keep it whole.

Engineer Solution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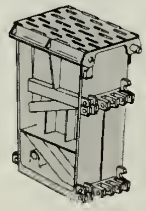
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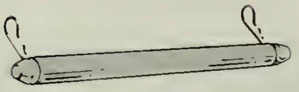
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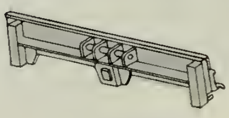
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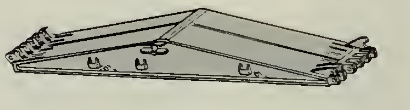
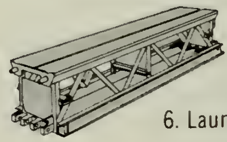
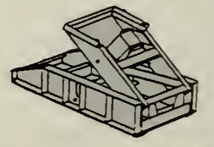
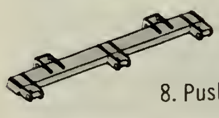

5. End Taper Panel


6. Launching Nose (Heavy)


7. Landing Roller Pedestal (Guillotine)


8. Push Bar Adapter

1-5 are components of the Bridge Set, MGB
6-8 are components of the Bridge Erection Set, MGB

The Corps and Town Building

by Dr. James W. Dunn

In December 1941 Congress handed the Corps of Engineers responsibility for all military construction, including troop housing. The Corps was already doing this job overseas, and Congress was impressed by the Corps' work on Army Air Corps construction in the States since the fall of 1940.

Until then, however, sheltering troops had been the Quartermaster General's job. So what qualified the Corps for its new and massive task on the eve of World War II? The Army Air Corps work, the overseas mission—and something else.

In the depression years from 1933 to 1940, the Corps built, maintained, and administered towns for civilian workers at isolated dam construction sites in Montana, Maine, and New Mexico.

On October 14, 1933, President Roosevelt authorized the Fort Peck Dam as a Public Works Administration project, assigning construction to the Corps of Engineers. The dam would be built on the upper Missouri River about 20 miles southeast of Glasgow, Montana. Its site was near old Fort Peck, active during the Sioux Indian campaigns of the 1870s. A camp with employee housing had to be built—the Town of Fort Peck.

The Fort Peck district office opened in Glasgow on October 25, and work on the town began. The Corps built furnished quarters for 8,000 employees. Family houses with one, two, and three bedrooms included a dining room, living room, kitchen, and bath. Single employee quarters included both dormitories and barracks. Supervisors lived in dormitories; laborers lived in barracks built in an "H" configuration with 24 beds in each wing and a mess hall in the center.

A Corps of Engineers commissioned officer served as Fort Peck's town manager. The town buildings included a 40-bed hospital and a building for the small police force and volunteer fire department. A school served both elementary and high school students, and a business building housed barber and beauty shops, a drugstore, and department stores. The Corps also built a theater and a hotel.

The first homes were ready in September 1934, and on October 2 the Town of Fort Peck and the district office opened for business.

On May 17, 1935, the Corps established the Eastport Maine District to supervise construction of the Passamaquoddy hydroelectric project. Eastport, a village of about 3,200 people, had limited housing. When the first district employees arrived, rents doubled. The district had to scatter its offices over twenty localities. Building a living area for workers became the first order of business.

Quoddy Village was built on Moose Island, about 3 miles north of Eastport. Single, duplex, and apartment buildings provided housing for married employees. Single personnel lived in dormitories and barracks. Each dormitory had 87 single rooms and a mess hall. The twelve barracks were served by three mess halls.

The Corps built a laboratory, a 30-bed hospital, and a building for the police and fire departments. The town produced a newspaper, and organized Scout Troops, a garden club, and a junior theater guild. Construction began in August; the first employees moved in by late December, 1935.

A third project, the Conchas Dam on the South Canadian River in northeast New Mexico, was authorized under the Emergency Relief Appropriations Act of 1935. The site, about 35 miles northwest of Tucumcari in a remote area, needed offices and employee housing.

The buildings at the Conchas Dam Construction Camp were built of adobe brick in the low, flat-roofed pueblo style. Married employees had one- and two-bedroom apartments and three-bedroom houses with a living room, dining room, kitchen, and bath. Single employees lived in barracks, with laborers in 20-bed wings and supervisors in single rooms. The mess halls were in separate buildings.

The town manager, a Corps commissioned officer, had offices in the town hall. The Corps built a business building, a hotel, and a 24-bed hospital. In the first year only an elementary school was available, but by 1937 the New Mexico State Board of Education had also established a high school. The Conchas Dam Recreation Association boasted a 9-hole golf course, tennis courts, and riding and drama clubs. Employees occupied the first quarters in May 1936, and in October the Conchas District and the town opened for business.

Two towns survived only briefly. The first to go was Quoddy Village. The Passamaquoddy project proved too expensive for Roosevelt's administration, and the Eastport District closed on October 31, 1936. The National Youth Administration took over the Quoddy Village buildings. The Corps completed the Conchas Dam in the summer of 1939, and in February 1940, the National Park Service took over the Conchas Dam Construction Camp.

The Town of Fort Peck is still in business. In June 1987, on the 50th anniversary of the dam closure, the Fort Peck community numbered about 300 residents. Of course the Corps no longer administers the town, but the hotel is open, and the theater is listed in the National Register of Historic Buildings.

Suggested Reading: Aubrey Parkman, *Army Engineers in New England;* Michael Welsh, *A Mission in the Desert;* Omaha District, U.S. Army Corps of Engineers, The Federal Engineer, *Dam Sites to Missile Sites.*

Dr. James W. Dunn is an Historian with the Office of History, U.S. Army Corps of Engineers.

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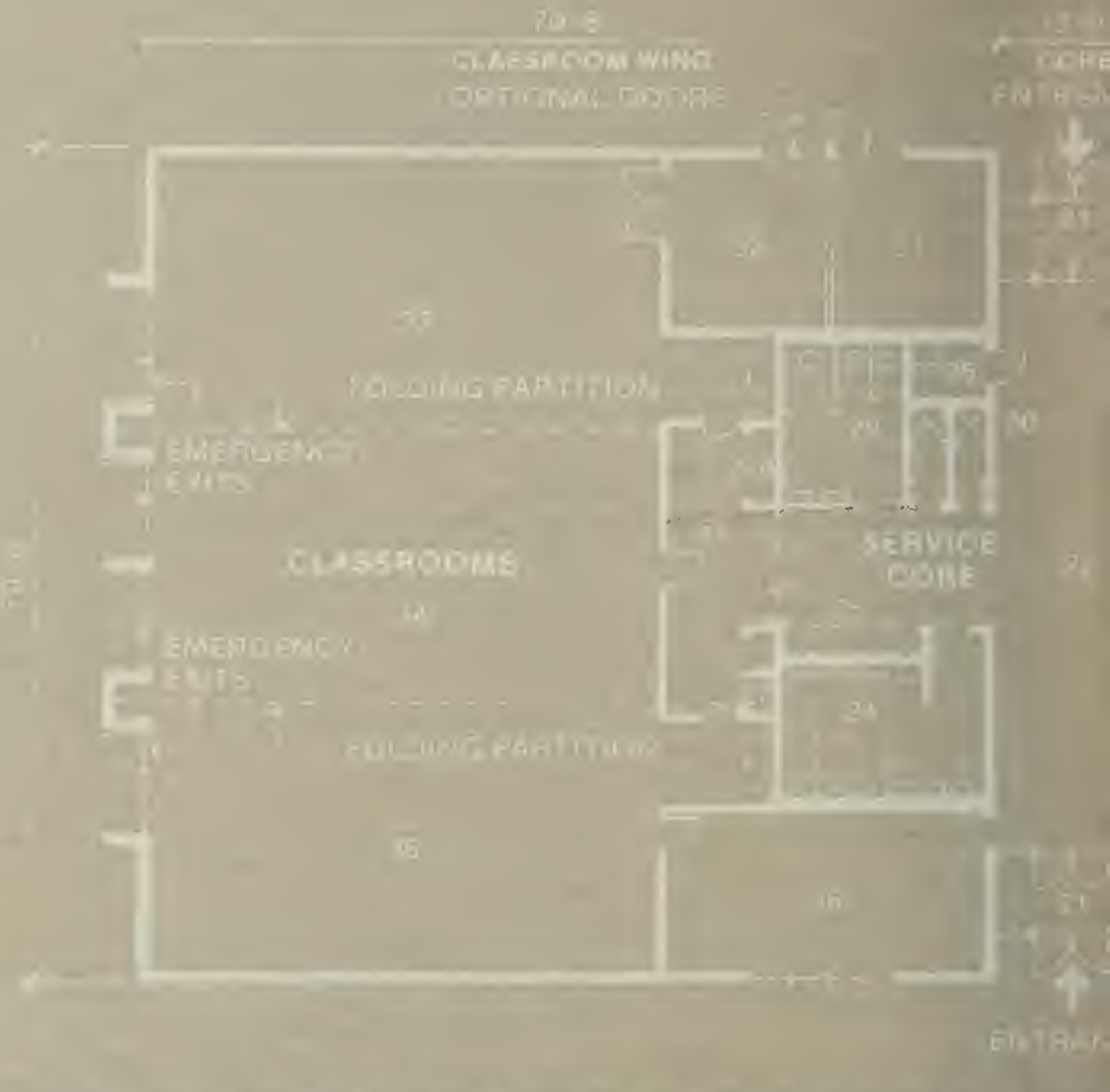

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Personal Viewpoint

MISSION TRAINING PLANS RESULT IN BETTER TRAINING

by CPT Warren R. Waldorff

Variations in existing ARTEPs allow too much room for subjective interpretation in training and evaluation. They also have inconsistent standards in other ARTEPs for the same task. Generally, engineers should have to meet the same standards in accomplishing the mission or task regardless of how they get there, who they support, or who is training and/or evaluating. Of course, the methods, techniques and procedures will differ with the ingenuity and innovation of the leader, but the standards remain the same. These problems and others are being resolved in the development of ARTEP mission training plans (MTPs). MTPs will replace existing ARTEP manuals over the next several years. Some of the characteristics of the MTPs include objective standards, standardized tasks, situational/field training exercises (STX/FTXs), and an improved development process.

Subjective evaluation of ARTEP standards also causes training to be conducted subjectively. Trainers and evaluators alike rely on their own experiences, beliefs, and "the way we did it in my last unit" to establish standards. This results in conflict and inconsistencies in training and evaluating to these standards. MTP standards are more quantitative, measurable, observable, and objective. The intent of objective standards is for anyone, regardless of experience or expertise, to read the words on the page and interpret, unequivocally, the same meaning. MTP standards are not subject to broad interpretation.

A second problem is standardization. Currently, the same task appears in different ARTEPs with different standards. A soldier, previously assigned to a divisional engineer unit, must perform collective tasks to different standards in a corps engineer unit. Although the means by which they get to the battlefield may be different, the standards to which they perform the task should be the same. MTPs rectify this problem through horizontal alignment. Where ARTEPs address the battalion, company, and platoon in one book, MTPs address only one echelon in each book. Additionally, the MTP applies to all engineer units with a similar organization and mission; thus the horizontal alignment. For example, the MTP for the heavy division engineer platoon also applies to corps and armored cavalry regiment engineer platoons. Of course, there are a few differing tasks, and they will be included. However, the majority of the tasks, once the unit arrives at its destination, are performed to the same standards.

Another feature of the MTP is more "how to train" material. Situational and field training exercise examples are given in each book to illustrate conducting training exercises from "A to Z." Each example contains a detailed plan, scenario, sequence of events, support, and OPFOR requirements.

Additionally, the quality of the MTP was improved by means of a development process involving maximum field input and a "top-down" approach. Recently, we invited several battalion commanders from light engineer units to develop the framework for their MTPs. The commanders' first-hand experience, expertise, and frustration with existing ARTEPs were largely responsible for the development of practical, usable MTPs. The "top-down" approach involves conducting a Directors' Executive Committee Meeting (DEXCOM), headed by the Assistant Commandant and attended by all colonels at the Engineer School, to develop the task list and framework for each MTP. Both quality assurance methods provide for better MTPs, produced more quickly.

Other strategies used to hasten development are creative swiping and skunkworks. In creative swiping, MTPs are collected from all the other schools and analyzed. The best parts of each book are modified and included in engineer MTPs. This "best of the rest" strategy enables engineer MTPs to be of the highest quality without "reinventing the wheel." In skunkworks, assets and resources are consolidated in one location to perform the majority (approximately 90 percent) of the development. This strategy circumvents the red tape of bureacracy and facilitates direct and timely coordination between functions.

As the MTPs reach field units, it is imperative for those seeking to gain an advantage in training to read, understand, and implement the revolutionary improvements provided by mission training plans. The units whose leaders quickly embrace MTP concepts will stand high above the rest.

CPT Warren R. Waldorff is a team chief in the Directorate of Training and Doctrine at the U.S. Army Engineer School. His assignments include platoon leader, assistant S3, and executive officer in the 237th Engineer Battalion, Heilbronn, FRG. He was also #33 on the gridiron at West Point.

Engineer

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About the cover

The Electronic Information Delivery System (EIDS) is the latest in training devices. Soldiers can gain current Army doctrinal procedures for their branch/MOS by calling up training situations on the videodisc computer.

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CLEAR THE WAY

by MG Daniel R. Schroeder
Commandant, U.S. Army Engineer School

ON WARFIGHTING

"No method of education, no system of promotions, no amount of common sense or ability is of value unless the leader has in him the root of the matter—The Fighting Spirit."—Field Marshall Earl Wavel

Members of our profession hardly need reminding to focus on warfighting—that is our business. Yet over time, imperceptible and seemingly insignificant shifts in focus can occur, resulting in a posture far different from that intended. In our business, such a failing portends the worst possible consequences.

As we engineers begin a new era at an Engineer Center unified in command, location, and spirit, it is appropriate to review where we are and where we are going, and to ensure we are truly focused on warfighting in three key areas: combat developments, doctrine and training literature, and training.

COMBAT DEVELOPMENTS

Implementation of E-Force is the single most important force structure contribution engineers can make to the Army's warfighting capability. ENGINEER featured an E-Force update in the last issue (July 1988). Testing and proof of the concept will occur soon at the task force and brigade levels in CONUS and at division and corps levels in USAREUR. We will then be a step closer to becoming the most effective engineer fighting organization ever.

Engineer equipment modernization efforts continue apace. The SEE is here and the M9 ACE is coming. Development of other systems essential to the fight—VOLCANO, TEXS, and CMV—continues. We are on the threshold of exciting new capabilities and challenges.

DOCTRINE AND TRAINING LITERATURE

We have a new capstone doctrinal manual: FM 5-100, Engineer Combat Operations, has been through rigorous reviews and is ready for publication. You will receive it with these obligations: Study the principles of how we support the combined arms fight in the AirLand Battle, learn it, apply it, and teach it to subordinates and our brothers in arms. See to it, and then do the same for the following doctrinal manuals: FM 5-116, Engineer Operations: Echelons Above Corps; FM 5-71-100, Engineer Support to Close Combat Heavy Forces; and FM 5-71-101, Engineer Support to Close Combat Light Forces.

Training literature development progressed equally. The old ARTEP manuals are being replaced by ARTEP Mission Training Plans (MTP). Final MTPs for heavy engineer units are being readied for distribution. MTPs for combat heavy elements are being written now for publication by the end of FY89. In every case, the emphasis is on key combat tasks and standards relevant to the desired effect on the enemy.

New Soldier's Manuals are coming. The logical outgrowth of MTPs, they are concise sets of individual tasks that enable units to accomplish their collective combat missions. You will receive them in FY90.

Battle drills, an essential bridge between individual and collective training, are a high priority. A set of drills limited to key warfighting missions are planned for distribution by the end of 1988.

Other training literature, such as Reserve Component Configured Courseware and the STRAC manual (see "STRAC," page 9) contribute to the warfighting focus.

TRAINING

Structure changes, equipment modernization, doctrine, training requirements, and standards are integrated and synchronized through individual and collective training. The School and Center consolidation enables us to alter individual training dramatically.

My predecessor, MG Bill Reno, embarked on an ambitious review of EOBC, EOAC, and ANCOC training. His objective was to ensure the right kinds and proportions of warfighting training in those courses while ensuring training among all courses was horizontally and vertically integrated. We will follow through on those changes not already implemented. Further, we will continue to find more (and better) ways to enhance the technical competence and tactical proficiency of all engineer soldiers. Fort Leonard Wood's greater availability of ranges and close-in areas for realistic training provide that long-sought opportunity.

Much of the success in training is tied to the doctrine and training literature already discussed. Still more is dependent on the availability of adequate training devices, such as Placed Training Mines (see "Realistic Training on a Budget: The Device Solution," page 24). But perhaps the most important element of all is our ability, as leaders, to ensure we train well with the right fight focus—WARFIGHTING.

SCHOOL NEWS

Directorate of Combat Developments (DCA)

New TOE ranger slots Headquarters TRADOC has recently approved coding several officer positions in the Engineer Battalion, Light Infantry Division (TOE 05-155L) to be filled by ranger-qualified officers (ASI 5R). Though no additional positions in the HHC were authorized, the company commander, company executive officer, and both platoon leader slots in the engineer company are coded for rangers.

This change is the result of a USAES effort, approved by TRADOC and DA DCSOPS, to gain additional ranger training quotas and provide Light Division engineer officers with training on a par with that received by their maneuver battalion counterparts.

DCD point of contact for this TOC change is Mr. John Leinenbach. ATZT-CDO, Fort Leonard Wood, MO 65473. He can be reached at AV 581-6924.

CAREER NOTES

Sapper Leader Course Grads

Seeking airborne/ranger volunteers Looking for a challenge, something that automatically identifies you as a cut above? Why not try to win the coveted ranger tab and/or airborne wings?

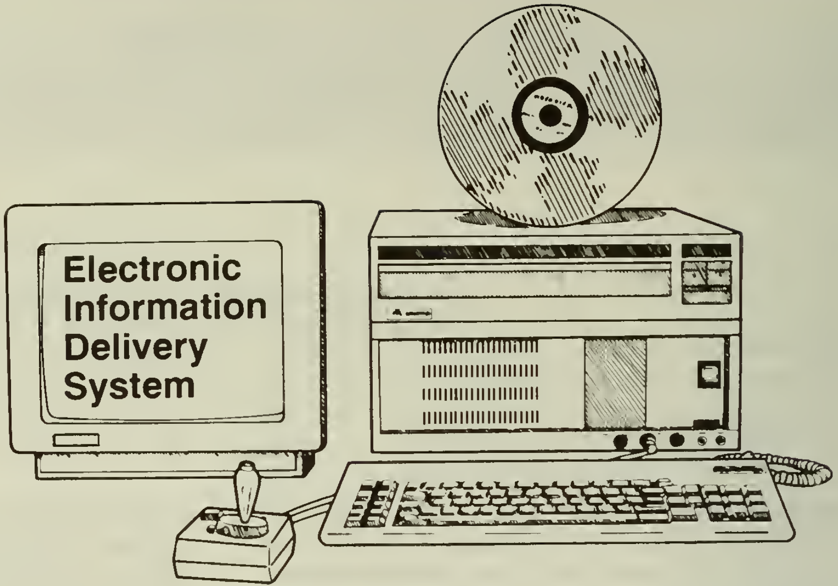
Many of the 12B SAPPER positions in the Light Infantry Division now require ranger qualification and volunteers for this arduous and exciting training are being accepted. There is also a continuous requirement for airborne qualified soldiers in most of the engineer MOSs to provide the rotation base for airborne units.

Apply through command/personnel channels following the procedures outlined in Chapter 6, AR 614-200 and DA Pam 600-8. Successful graduates can look forward to challenging assignments in the light divisions or with the airborne engineers.

Survival, evasion, resistance, and escape (SERE) training course Senior NCOs who enjoy excitement may find the SERE training course may be just what they're looking for. SERE is a difficult 18-day course emphasizing survival situations and needs; escape and evasion techniques; and methods of resistance to enemy interrogation, indoctrination, and exploitation. The course involves high levels of physical and mental stress that require a great personal commitment by each partcipant for successful completion.

Senior NCOs who anticipate assignment to a battalion or higher S2 position will find this a good TDY enroute course to take. Interested NCOs can call their TAPA career advisor, AV 325-7710/7711, for additional information.

EIDS BRINGS INTERACTIVE TRAINING TO ENGINEERS



by Margaret C. White

Standardized computer and video training will soon become a reality for engineers and other branches of the U. S. Army. The long-awaited Electronic Information Delivery System (EIDS) training devices are now being distributed to TRADOC schools and will be fielded to learning centers for active and reserve units.

With the fielding of EIDS, engineer interactive courseware (ICW) is also being developed. Numerous videodisc programs and computer-based instruction materials will soon be available to the Engineer School for supplemental training and to units for refresher training.

The *Task Force Engineer In Defensive Operations* is a simulation of the Tactical Exercise Without Troops (TEWT) of the Manassas Battlefield terrain. It gives the student a chance to practice land navigation skills and preparation of engineer plans and work estimates.

The *Minefield Breaching Battledrill Evaluation* also employs the full capability of EIDS by displaying a video scenario and mission, and then allowing the squad leader student to make decisions to breach a minefield. If the student responds incorrectly, the consequences are shown as an unsuccessful breach; with the correct response, a successful breach is displayed.

Interactive courseware on *Nonstandard And Standard Fixed Bridging* may be available Summer 1989. This courseware includes training on 14 bridging tasks from classification to construction and supervision of various bridges. The courseware will consist of three videodiscs and will display video segments and still photos of construction and bridging components and provide practical exercises and immediate feedback to the student. Similarly, *Roads and Airfields* courseware trains 16 construction and planning tasks that will supplement existing courses using the multimedia characteristics available with EIDS. The table on page 7 gives the projected availability dates for planned EIDS training programs.

While other TRADOC schools have geared their interactive courseware to the training needs of the AIT and BNCOC students, the Engineer School's focus was originally with the Engineer Officer Basic Course, training important decision-making and planning skills required of the platoon leader. However, with EIDS capabilities and with careful planning in the design of the courseware, we can develop one training effort that meets the needs of multiple groups. An excellent example of this is our proposed use of an existing videodisc training program developed by the Infantry School, *Military Operations In Urban Terrain*. The Engineer School is adding computer text and overlaying graphics to this video (which displays reconnaissance of a German village) to incorporate engineer role-playing, obstacle planning, and other engineer tasks.

Computer-based instruction, without interactive videodiscs to store video and audio information, can also be run on EIDS. The Engineer School is currently converting selected PLATO lessons to Micro-PLATO and then to MS-DOS and EIDS. These lessons are now exportable to users in the field who have access to EIDS or to an MS-DOS compatible computer.

To manage EIDS and associated ICW effectively, the Army and proponent service schools must develop sound strategies and implementation plans before developing courseware. The Engineer School is dedicated to providing required courseware for the entire engineer community that will meet short and long-term training goals.

The following excerpt from *The EIDS Primer*, reprinted with permission from TRADOC, will answer most questions about the new system's features and distribution plan:

The electronic information delivery system (EIDS) introduces an innovative system that will have a profound impact throughout the Army. EIDS was developed to remedy clearly identified shortcomings in the current Army system for storing and delivering technical, doctrinal, and training information. Now we must develop strategies to use its capabilities for both resident and nonresident training most effectively and efficiently.

This article provides an overview of the system's components, capabilities, operations, maintenance, and applications for training.

EIDS is a general-purpose training system. The basic system is used as a personal workstation to train individual soldiers. It can be used in a classroom by adding a large projection screen or additional monitors. Workstations can also be linked in a network of students and instructors.

The system is a totally new approach to delivering Army doctrinal, training, and technical information. Using interactive videodiscs (IVDs), EIDS takes advantage of recent state-of-the-art advances in microcomputer and visual information. The basic system consists of a videodisc player (VDP) and microcomputer subsystem (MS), monitor, and user input devices.

EIDS is fully compatible with all MS-DOS software packages and with all IBM-compatible PC expansion boards. The system design uses standards to ensure compatibility and to enable future upgrading.

In a compact, low-cost package, EIDS is an interactive computer-based training system with the enhanced audio and video capabilities of conventional videodiscs. It also has the tremendous data storage capabilities offered by hybrid videodisc technology.

EIDS can solve many problems existing in current training systems. It is a table of distribution and allowances (TDA) item, managed through the training and audiovisual support center/visual information (TASC/VI) activities system.

Development

During EIDS' development, two alternative IVD systems were built using off-the-shelf components—

A student uses a light pen to mark his responses to a training program at an EIDS workstation.

- The Apple II microcomputer with floppy disk drives, Sony PYM-120Q monitor, Pioneer videodisc player, and Allen communications VMI interface.
- The Sony SMC-70 microcomputer, Sony PVM-1270Q monitor, Sony LDP-10000 or 10000A videodisc, and Sony floppy disk drives.

Both hardware systems confirmed the value of this method of courseware delivery. Both proved that IVD systems, in general, are valuable, cost-effective resources. However, hardware and software compatibility problems existed. For large scale dissemination of information, the Army found standardization to be the only alternative.

After these initial efforts, the Army awarded three parallel contracts to incorporate compressed audio and to improve system design. After delivery and testing of the advanced development models, the Army chose the Matrox model and decided to field EIDS.

Components

EIDS consists of the videodisc player and microcomputer subsystem, display subsystem (DS), standard peripheral devices, and other components described below.

The videodisc player and microcomputer subsystem include—

- 16-bit microprocessor (expandable).
- MS-DOS 3.2 operating system.
- 512K expandable random access memory (RAM).
- 8-inch or 12-inch laser videodisc.
- Still-frame audio and digital data recovery unit.
- Built-in dual 3 1/2-inch auto shutter floppy disk drive.

It uses high-level languages such as Pascal, BASIC, FORTRAN, and Ada. It is compatible with PC AT hardware and software. It is also capable of extended graphics (720 by 480 pixels) by using an enhanced graphics adapter (EGA).

The overall dimensions of the unit are 17 inches long by 17.25 inches in diameter by 10 inches high. It weighs 48.5 pounds.

The display subsystem consists of a composite red, green, blue (RGB) color video monitor and an internal audio amplifier. Its dimensions are 14 inches long (front) by 12 inches in diameter by 13 inches high. It weighs 28 pounds.

Standard peripheral devices for the student station are a light pen and a keypad. Other components may include—

- Transit case, VDP and MS, reusable.

- Transit case, depot support, reusable.
- 19-inch rack vehicle mount kit for VDP and MS.
- Printer.
- Modem.
- Cables.
- Standard (QWERTY) keyboard for development system.
- Joystick.
- Mouse.
- Trackball.
- Remote control for videodisc player.
- Headphones.
- External magnetic mass storage device.
- 5 1/4-inch dual floppy disk drives.
- NTSC monitor with touch panel (infrared type).

Additional items may be added via standard RS-232C port.

Capabilities

Self-Diagnosis. The system master power switch, located on the front of the VDP and MS, turns the system on. It automatically performs self-tests to verify that all components are functional, including a test to detect defective memory, and identifies any failures to the user. The self-tests take about a minute, after which the operator follows the computer text instructions appearing on the screen. Controls and commands are entered with peripherals such as a light pen or keypad.

User interface. EIDS is built using specially designed AT microcomputer bus components. Its operation is similar to that of an embedded AT microcomputer with additional functions for training and simulation applications. Its software is "menu-driven."

Record keeping. The system can register students and other users. It can generate electronic records with various levels of access, depending on the user's status. In the training mode, it can calculate and preserve test scores and performance records based on student responses, providing feedback when required.

Presentation Management

EIDS will–

- Process responses entered from a keypad, light pen, standard QWERTY keyboard, mouse, joystick, track ball, or a touch panel screen when available.
- Present feedback messages to users. These messages tell users how to proceed through the program.
- Manage the time and order of presentation, instruction, and test sequences.
- Load all computer programs, including the operating system, from the videodisc.
- Play back video images (motion or still frame), computer-generated text and graphics, and digital audio simultaneously on command.
- Control microcomputer linear or branched program function.
- Operate the VDP with the associated monitor in its operational mode independent of computer control.

Graphics. The system will have computer graphics capability with a minimum resolution of 720 by 480 pixels and at least 16 colors. The videodisc player is a frontloading model, able to display frame numbers, as well as inform the central processing unit (CPU) which frame is accessed, via a bidirectional communication link between the player and the microprocessor. This provides the player status, which includes but is not limited to, player initialize/ready, audio channel used, and frame display. EIDS can play uninterrupted audio segments as short as 10 milliseconds and as long as 65 seconds.

EIDS is capable of–

- Intermixing programs containing still frames, still frames with compressed audio, full motion sequences, and digital text.
- Randomly accessing any single frame or a programmed series of frames by using system software.
- Displaying stationary images of a particular image, with a minimum of 65 seconds of compressed audio per frame.
- Displaying programmed information in forward or reverse in a fast-search mode, one frame advance mode, or in variable slow-motion mode.
- Switching between videodisc and computer graphics and superimposing computer-generated text and graphics on video images from the videodisc.
- Generating and displaying full-color, high-resolution computer graphics to support computer-assisted instruction (CAI), using floppy disk, disk drive, or videodisc and keyboard peripheral.

Mass storage. The system is capable of–

- Storing up to 54,000 frames on one side of the videodisc.
- Storing digital data equivalent to 4,200 standard 5 1/4-inch floppy disks on one side of the videodisc.
- Storing over 60 hours of audio on one side of the videodisc.

User manual. Matrox will provide an operator's technical manual to explain how to operate and maintain EIDS. A videotape and ICW product are also being developed to explain how the training delivery system can support various types of training.

Expandability

EIDS was specifically designed for expansion. Three vacant board positions can host a variety of products. The following is a list of expansion capabilities to consider for development–

- Microcomputer bus architecture.
- Memory boards (2 megabytes plus).
- RS-232C and IEEE 488 receptables.
- Alternative alphanumeric displays (character sets, symbols).
- Programmable coprocessor and memory.

- Digitized video.
- Network interface and protocol boards.
- Extra serial and parallel ports.
- Voice synthesis and recognition capabilities.
- Interface boards for CD, ROM, DRAW, bubble, and other technologies.

Training Applications

EIDS can integrate the delivery of all existing visual information such as print, film, videotape, transparencies, and sound and slide products. The system hardware and its supporting courseware allow individual interactive training and two-dimentional simulation, thereby extending training dollars. By allowing more simulated hands-on training, EIDS reduces the reliance on costly, low-density equipment or full-scale, high-fidelity simulators. It also reduces spare parts use and maintenance requirements. It can provide challenging surrogate travel simulations, leadership scenarios and realistic tactical exercises without troops.

Service schools, other government agencies, and private industry have developed many cost-effective training techniques for interactive instruction to help resolve specific training deficiencies. EIDS will standardize this training. Courseware developed for resident training can also be used for distributed training. This concept requires that both resident and nonresident training materials be developed concurrently. Using this concept allows developers to further training standardization by exporting instruction and training techniques to the field.

Training developers may find that developing courseware for EIDS is more challenging and sophisticated than preparing traditional linear training materials. However, the design and development of both use similar procedures. A broad knowledge of instructional techniques, design processes, and Army training development policy is necessary to understand the procedures for developing ICW. Interactive courseware, like traditional training materials, must be prepared according to TRADOC Regulation 350-7, which delineates policies, requirements, and responsibilities for developing instructional materials.

To help schools develop courseware for EIDS, TRADOC designed, developed, and validated several ongoing workshops covering the skills and knowledge needed to produce videodisc training materials.

ENGINEER INTERACTIVE COURSEWARE FOR EIDS

TITLE	AVAILABLE
Construction Equipment Supervision (62N)	Fall 88
Task Force Engineer (TFE) In Defensive Operations	Fall 88
Minefield Breaching Battledrill Evalution (MBBE)	Fall 88
Terrain Analysis and Appreciation	Winter 89
Route Reconnaissance	Summer 89
Combined Arms River Crossing Exercise	Summer 89
Nonstandard and Standard Fixed Bridging	Fall 89
Roads and Airfields	Fall 89
Military Operations in Urban Terrain (MOUT) – Engineer	Fall 89
Operation/Maintenance of Crawler Tractor and Motorized Grader (62E)	Winter 90
Project Planning (CMF 51)	Summer 90
Construction Print Reading (CMF 51)	Fall 90
Cartography	Winter 91

Maintenance Support

EIDS is a modified nondevelopmental item that will rely on government and limited contractor support throughout its life cycle. The system production contract will contain a total performance warranty covering system operation for at least one year. Warranty actions will be processed through the TASC/VI activity to the supporting contractor.

Initial spares will be procured and delivered with the initial production contract. A planned warranty program will minimize the number of government-supplied spares required for the first year of operation. However, out-of-warranty failure of spares caused by the user will still require support during the first year of operation.

The proposed maintenance concept is to return EIDS for maintenance through the local TASC/VI activity to the depot. Users will not require special maintenance skills. Users will report nonfunctioning systems to the TASC/VI activity. The TASC/VI activity will troubleshoot only down to a major assembly by using on-hand test, measurement, and diagnostic equipment. TASC/VI activity personnel currently possess the skills required to perform organizational maintenance of EIDS.

If the local TASC/VI activity cannot repair the item, it will ship the end item or assembly to the Army depot for repair and requisition a replacement item through the Army supply system. The Army depot will either repair the item in-house or use a contractor repair facility. TASC/VI activities and depots will stock spare major end items, assemblies, accessories, and cables. Users will requisition replacement items through the Army supply system, using assigned NSN for each major EIDS component.

Distribution

EIDS will be distributed to TRADOC and FORSCOM schools, Army learning centers for Active and Reserve Components, field units, and Reserve Forces schools, National Guard academies and armories, consolidated training activities, and regional training sites-maintenance. The TASC/VI activities will manage and account for EIDS, ensuring that the precepts below are followed—

- Hardware procurement is based on validated requirements.
- EIDS fielding is based on courseware availability and implementation strategy.
- Appropriate maintenance procedures are followed.
- Usage data is collected and reported.
- Replacement equipment is adequately programmed.
- Hardware is redistributed based on usage and training needs.

To manage EIDS effectively, the Army and proponent service schools must develop both sound strategies and implementation plans before deploying both hardware and courseware.

Hardware Fielding Plan

When EIDS' hardware is distributed, it must be protected from moisture, excessive temperature, and fluctuation of electrical power. Therefore, required upgrading of facilities for space, cooling, and electrical power must occur prior to distribution.

The initial distribution began second quarter FY88. EIDS distribution is based on courseware availability, the proponent's implementation plan, and the total Army EIDS strategy. To convert existing interactive courseware to develop other programmed interactive-ware and to use for resident instruction, TRADOC service schools will receive the majority of the first shipment. Selected field units will receive a limited number of EIDS from subsequent distributions to support a test and evaluation of the total Army EIDS strategy. Operational fielding to units will benefit from the lessons learned during this evaluation.

Courseware Fielding Plan

The determination of who is to be trained, at which locations, and in what numbers will drive ICW replication and distribution. Joint Visual Information Service (JVIS), Tobyhanna, PA, will initially distribute (push) ICW through TASC/VI activities to users. Active and Reserve Component users may request additional copies of ICW, through pull distribution, after they evaluate the applicability and use of the material.

JVIS will label and package all ICW. The package will include instructions on how to use EIDS and a description of the subject or tasks taught in the courseware. The ICW distribution plan will cite individual and collective tasks supported by the courseware, which will help determine the specific ICW recipients.

ICW Developments and Authoring Systems

The Production Management System (PMS) was intially developed to meet the specific needs of ICW development. PMS is a software system designed as an automated management program to keep track of large quantities of storyboards. During the evolution of the software system, user-requested enhancements moved it out of the realm of its production orientation. As more authoring capabilities were incorporated into the software, a name change became necessary. PMS became EIDS ASSIST (electronic information delivery system authoring software system for interactive simulation and training).

As the name implies, EIDS ASSIST goes beyond PMS. It supports limited simulation capabilities as well as more complete authoring capabilities. Its user-friendly system provides on-line, content-sensitive help prompts that are available at any time during the courseware development process. Written in a higher order language, its efficient management functions and program speed provide tremendous cost savings in all phases of ICW development. Using EIDS ASSIST, ICW developers can now program their own training materials using a system specifically designed for the unique capabilities of EIDS and the training developer's needs. This authoring system will enable the ICW developer to generate scripts and reports, electronic storyboards, records of video and audio elements, and production schedules and data bases. It provides access to a full range of programming functions.

EIDS ASSIST was developed by the government which retains the right to change, modify, or expand the software for in-house development or use by government contractors. EIDS ASSIST eliminates the requirement for a computer programmer because it generates complete player, computer, and user interface control software. Still an evolving system, EIDS will be continually improved and updated to meet computer-assisted instruction training developer needs.

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STRAC

evaluation of ammunition requirements

by Saundra L. Smith

This article provides an introduction to the background, current issues and future initiatives in the STRAC program.

The STRAC program evolved from findings of the Army Training Support Center (ATSC) Weapons Crew Training Study Group (WCTSG) which determined that there were no standards across the Army for weapons qualification; nonstandard methods were used to determine the ammunition requirements; that many fielded devices and simulators were not being integrated into units' training programs; that costs of replacement ammunition and particularly ammunition for new weapon systems were increasing and that a credibility gap was growing between what the Army said it needed for training and what it was actually getting. Despite this discrepancy, the Army was reporting it was "ready." The STRAC Program Directorate (SPD) was established in 1982 to develop weapons programs for all weapons systems.

The Department of the Army STRAC program began in 1982 as a management initiative of the Vice Chief of Staff, Army (VCSA) and it continues to evolve. The engineer portion of the program was completely revised and involved significant changes in training standards and requirements from the old program contained in DA Cir 350-85-4, 16 September 1985. The new document, DA Pamphlet 350-38, 1 July 1987, provides DA requirements for weapons and weapon systems used throughout the force by both Active and Reserve Components. The new program appeals to commanders by providing the following features:

> **...a credibility gap was growing between what the Army said it needed for training and what it was actually getting.**

- suggested weapons training strategies that will lead to the attainment and sustainment of standards.
- measurable standards for evaluating a portion of their overall training readiness.
- a common set of weapons and weapon system qualification standards.

Training programs were developed by school weapons committees, comprised of the school commandant or assistant commandant and representatives from the MACOMs, National Guard (NG), and Reserve (USAR). The committee developed the base programs for each weapon system along with a training program that, when executed, will lead to attainment and sustainment of the standards. Ammunition requirements to support the training programs were determined and devices and simulators integrated into the program. Training Readiness Conditions (TRC) were considered to account for the constrained training time available to the NG and USAR units. The training programs were developed based on the Army Training and Evaluation Program (ARTEP) missions, field manual (FM), soldier's manual (SM) and field circular (FC) tasks; required tasks for each firing level; field input and integration of training devices.

After a major engineer program rewrite, DA Pam 350-38, 1 July 1987, contains the current training standards, strategies, and resource requirements to conduct training with engineer systems, mines and demolitions. Each program has been tied directly to soldier's manual and ARTEP tasks/missions at the different TRCs and includes frequencies for live fire, subcaliber fire, and device usage. Commanders should be made aware that the suggested training programs allow them to use allocated ammunition as deemed necessary, based on individual analysis of the strengths and weaknesses of the unit.

Mine warfare. In response to recent concerns on safety, the CG rescinded all STRAC live mine training requirements. This decision was based on the lack of research data on the safety of multiple arming and disarming of live mines (as required in STRAC). This rescission will remain in effect until the USAES reviews the data received recently from the Army Materiel Command. New live mine training restrictions are as follows:

- No live mine training will be conducted on antipersonnel mines.
- Live mine training on M15 and M21 antitank mines is permitted at the discretion of commanders subject to these restrictions.
- Tilt rods/extension and/or extension rod adapters will not be installed.
- Antihandling devices and trip wires will not be used.
- Neither mine will be armed/disarmed more than 50 times before destruction.
- Live mine training is not permitted on any other mine.

FY88 evaluation. The FY88 evaluation is on-going. The focus of this effort is to evaluate the revised STRAC programs contained in the new DA Pam 350-38, effective 1 Oct 87. The new engineer program was revised based on the FY86 evaluation, new or revised training strategies, increased incorporation of devices/simulations and historical ammunition usage.

Unit commanders indicate that they cannot get engineer munitions in amounts appropriate to ensure individual and collective weapons proficiency.

Unit commanders indicate that they cannot get engineer munitions in amounts appropriate to ensure individual and collective weapons proficiency. On the other hand, ammunition usage data shows that all allocated munitions are not being expended. The STRAC Program Directorate recognizes that a dichotomy exists and has formulated a HQDA team to assess ammunition management. However, units share a role in the solution of this problem and should designate knowledgeable people to participate in the ongoing evaluation.

This evaluation is the vehicle by which changes are made to existing programs. Units should also ensure that local ammunition managers are requesting the appropriate amounts of munitions and are allocating those munitions for their use. This effort should help close the expenditure gap through well-planned, managed and executed training programs. The Engineer School will continue its efforts to ensure that DA allocates the ammunition required by STRAC.

STRAC weapons program reviews. The CG, TRADOC has instructed the proponent schools to validate the training programs because so many units were reporting not meeting the standards. To support this effort, the Engineer School will reexamine all weapon system design capabilities and their relation to current standards; reevaluate percentage requirements for attainment of standards as they equate to combat readiness; and review training regulations, POIs, lessons learned, devices/simulators and all other components affecting training.

STRAC continues to be a dynamic program. The addition of new weapon systems, incorporation of new and improved devices/-simulators as well as changes in training strategies require that our systems be continually updated. Because we are using STRAC to determine our training ammunition requirements, it is important that units give the ongoing evaluation and the program its fullest support.

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RESERVE COMPONENT CONFIGURED COURSEWARE (RC3)

NCOES and reclassification training for the Reserves

by CPT Thomas Round

Anyone involved with MOS reclassification training in the Reserve Components (RC) knows that this has been a long-standing problem. The solution now lies within reach if we implement the training strategies and methods proposed by the Engineer School. Reserve Component Configured Courseware (RC3) will reduce the burden of reclassification training and NCOES as well. Let us examine the various training standards, RC-unique situations, and the RC3 program.

The operating standard for training Active and Reserve Components (AC & RC) for each MOS and skill code is completion of the appropriate resident course. This standard is met for all soldiers during initial entry training. For MOS reclassification or professional development training, only those RC soldiers electing to attend an AC resident course will be trained to the AC operating standard.

A resident course trains each critical task to a level of proficiency. That level may be one of knowledge, skill, or both. Knowledge proficiency is measured by written evaluation; skill proficiency by a performance test. When the minimum standard during an evaluation is met, proficiency has been achieved at that level of learning.

A resident course trains a critical task to at least knowledge proficiency, often referred to in soldier's manuals as "familiarization." A critical task trained to the knowledge level leaves training to the skill level to the soldier's assigned unit.

Time restraints placed upon the RC soldier may preclude attending an AC resident course beyond entry-level training. Therefore, the operating standard for RC training beyond entry level must become three-tiered:

See listing of available and planned Reserve Component courses on page 12.

(1) The *optimum* standard is what a resident course is training. The RC soldier becomes as proficient as an AC counterpart.

(2) The *RC typical* standard covers the majority of the courses developed for the RC. The RC soldier is as skill proficient after training as the AC counterpart in selected critical tasks, but is only knowledge proficient on the remaining tasks. Skill proficiency will be achieved at the unit if it is necessary to support the unit's mission.

(3) The *minimum* standard would train an RC soldier to be as proficient in knowledge as the AC counterpart, and skill proficiency would be achieved in the unit as required by the unit mission.

Some situations which impact on reclassification training are unique to the RC. A unit may be reorganized suddenly. A soldier may need to reclassify for upward mobility out of a "dead end" MOS. A soldier may change residence to an entirely different geographic region which has no unit similar to the one being left. A prior service AC soldier may wish to join a hometown RC unit and must be reclassified if the unit does not have that MOS.

An RC soldier is a "part-time" soldier and therefore has primary responsibility to a civilian employer and secondary responsibility to the unit. After initial entry training, an employer has a statutory obligation to grant only fifteen calendar days of military leave each year. The length of AC courses precludes the RC soldier from being able to attend and necessitates reconfiguration of RC courses for MOS reclassification and NCOES.

Reserve Component Configured Courseware (RC3) are adapted from resident courses and "mirror" the resident course as closely as possible. These courses include the same critical tasks as the resident course and train to the maximum extent possible. The objective is to train to the same level of proficiency as would be attained in the AC resident course. Noncritical and unit-trained critical tasks may not be included in an RC course.

RC configured courses may be taught by Army National Guard Academies, and U.S. Army Reserve Forces (USARF) Schools, Regional Training Sites-Maintenance (RTS-M). The courses are taught during active and inactive duty training (ADT & IDT).

Available RC Courses

MOS/SL	TITLE	AVAILABILITY DATE
62E10	Hvy Const Equip Oper	Aug 82
62F10	Crane Operator	Aug 82
51B10	Carpentry/Masonry Spec	Aug 83
62J10	Gen Const Equip Oper	Apr 84
81B10/20	Tech Drafting Spec	Aug 82
82B10	Construction Surveyor	Nov 83
12B10/12C10	Combat Engr/Bridge Crewman	Jun 88
12B/C/F30	Combat Engr CMF12 BNCOC	Jun 88
12B/C/F40	Combat Engr CMF12 ANCOC	Jun 88
51K10	Plumber	Jun 88
51R10	Interior Electrician	Jun 88

Courses To Be Completed by End of FY88

MOS/SL	TITLE	AVAILABILITY DATE
62B30	Const Equip Repairer BNCOC	Sep 88
51B10	Carpentry/Masonry Spec (Revision)	Sep 88
51H30	Const Engr Supv BNCOC	Oct 88
51M10	Firefighter	Oct 88

Courses Planned for Completion in FY89

MOS	TITLE
62B10	Const Equip Repairer
12F10	Engr Tracked Veh Crewman
62B10 RTSM-S	Constr Equip Rep RTSM Sustainment
51H40	Construction Engr Supv ANCOC
52G10	Transmission and Distribution Spec
62B30 RTSM-S	Const Equip Rep RTSM Sustainment
62H10	Concrete/Asphalt Equip Operator
62G10	Quarrying Specialist
62N40	Const Equip Supv ANCOC
62E10	Hvy Const Equip Operator (Revision)
62B RTSM-T	Const Equip Rep RTSM Transition
62N30	Const Equip Supv BNCOC
62J10	General Const Equip Operator (Revision)
62F10	Crane Operator (Revision)
210A *	Utility Operations and Maint Tech
213A *	Engr Equip Repair Tech

* Warrant Officer Technical Certification Course

The RC3 program goals are:

(1) To produce exportable training support packages for the RC that will train the critical tasks required for MOS qualification and provide for professional development programs.

(2) To develop a course management plan (CMP) and program of instruction (POI) for inclusion in each package that will provide detailed guidance for instructors.

(3) To provide resources to develop or revise RC courseware concurrently with resident courses at proponent service schools.

Guidance on new Reserve Component Configured Courseware is provided in TRADOC Regulation 351-1, TRADOC Pam 351-1, and TRADOC Regulation 351-13. The RC3 effort to complete all courseware has been programmed through the first quarter of FY90. The Engineer School effort is targeted at supporting MOS reclassification, NCOES, Warrant Officer Technical Certification Courses (WOTCC) and RTS-M.

TRADOC guidance provides that MOS reclassification and NCOES courses should be structured to allow completion in one training year:

(a) An MOS reclassification course, SL1, may consist of an IDT phase of 96-128 hours and an ADT phase of 80-120 hours (may be up to 130 hours with a 24-hour FTX).

Because of class preparation and administrative requirements on RF school instructors, the "rule" for IDT phase is 96 hours maximum. This equates to a maximum of 216 hours (226 with FTX) or 27 days of training.

(b) An RC BNCOC (SL3) includes 47 hours of IDT common leader training (CLT) which is Phase I and MOS-specific training which is Phase II. TRADOC guidance encourages proponents to structure Phase II for ADT only. Student population and time and distance factors may make Phase II IDT impracticable for certain MOSs. ADT length may be up to 120 hours or 130 hours with a 24-hour FTX.

(c) An RC ANCOC (SL4) includes 96 hours of IDT CLT as Phase I. Phase II is to be configured for ADT only. ADT length may be up to 120 hours, or 130 hours with a 24-hour FTX.

The RF schools, ARNG academies, and RTS-M all have restraints on accomplishment of RC soldier training:

(1) RC course instructors must be instructor-qualified and MOS-qualified for the course being taught.

(2) RF school instructors are obligated to perform 48 unit training assemblies (UTA) plus annual training (AT) each year. A UTA is four hours long and is usually accomplished in multiples of four (MUTA-4). A MUTA-4 equates to an IDT weekend training assembly (drill). Twenty-four UTAs are allowed the instructor for preparation and 24 for instruction. Twenty-four instruction UTAs equal 96 hours of instruction and six MUTA-4s.

(3) An RF school has no resources except people and its office/-classroom facility to support RC training. Equipment and materials required must be requested from supported units or other sources. Instructors travel to the students at a unit or central training location; this requires satellite training facilities.

(4) A minimum of 10 students are required for an RF school to teach a course (waivers may be requested). This is less critical at skill level one (SL1) than at SL3 and SL4 because density of potential trainees is greater. The normal instructor to student ratio during IDT is 1-10.

RC population density of an MOS and skill level is an important consideration when determining if a training need exists for MOS reclassification or NCOES. Other factors may also contribute to RC course requirements:

(a) The general rule is that an MOS skill level density of 500 is the minimum to warrant configuration of a course, unless directed by TRADOC. TRADOC has directed that all designated MOS, NCOES and RC Warrant Officer Technical Certification Courses (WOTCC-RC) be configured by end of FY89.

(b) The proponent may develop an RC course for an MOS with density less than 500, especially if a critical need is identified. For engineer MOSs a critical need exists because of RC mobilization training and requirements for formal school training to award the MOSs.

A Reserve Component course must be developed to minimize learning decay during the IDT phase. Training and testing of task(s) should be achievable during the 16-hour IDT. The available equipment, facilities, and training environment will impact when and where a task is trained. Performance-oriented or hands-on training may best be accomplished during ADT, while classroom lecture and written evaluations may easily be accomplished during IDT.

All equipment and materials to train the course must be identified in the Program of Instruction (POI). Special consideration must be given to the actual requirements of the course and the availability of the equipment in the supported units. Since the NG Academies and USARF Schools do not have equipment, the supported units must make it available.

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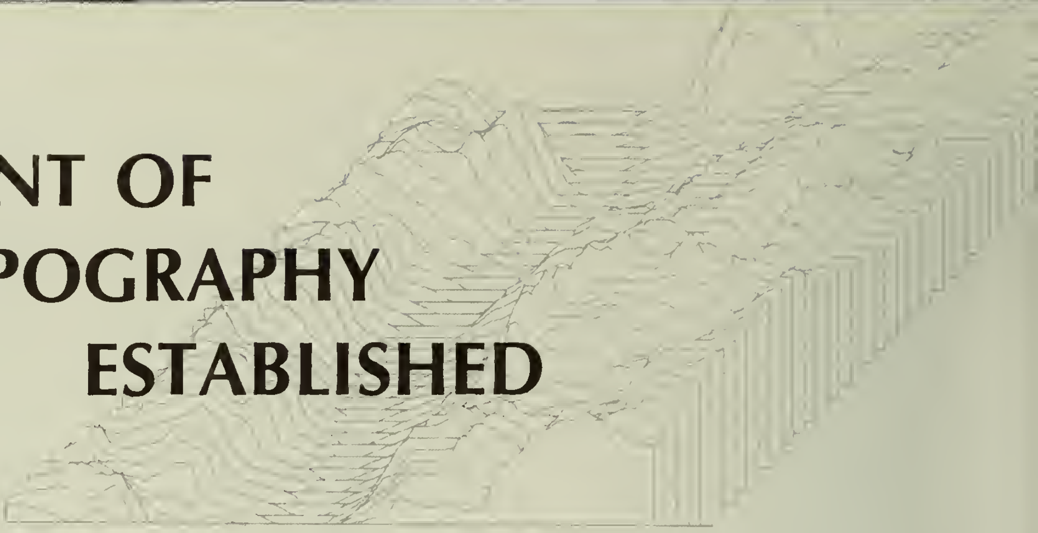


DEPARTMENT OF TOPOGRAPHY ESTABLISHED

by LTC Russell O. Reich, Jr.

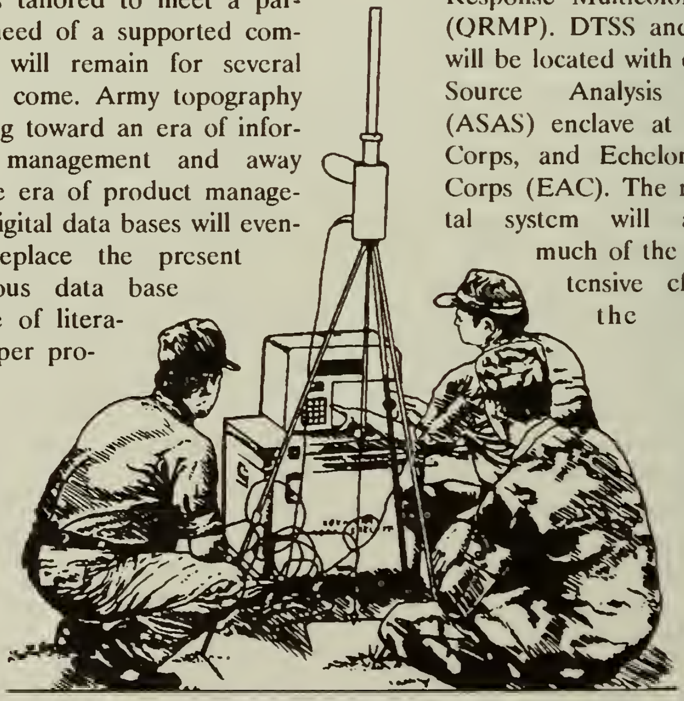
Since the formation of the Defense Mapping Agency (DMA) in 1972 from the Mapping, Charting, and Geodesy (MC&G) elements of the four armed services, Army topography has suffered. With DMA as program manager of all MC&G activities, engineers did not maintain a control element to ensure topography maintained pace to provide essential terrain information to supported commanders in the field. Without planning and direction and with advances in technology, many agencies entered the topography field, contributing to the fragmentation of this essential combat support.

The criticality of this organizational oversight became more apparent over time. In November 1987, the Engineer School reestablished the Department of Topography to regain control of its responsibilities to provide for organizing, training, developing material, and establishing doctrine for Army topographic forces. (A Department of Topography had been an essential element of the Engineer School until the formation of DMA, when this department became the Defense Mapping School [DMS].) While neat and tidy on an organization chart, topography ceased to be functionally effective. The Department of Topography must serve as the Engineer School's focal point for topography and integrate and focus the efforts of the other Engineer School directorates and academic departments, each with essential roles to play as topography moves toward a modernization master plan.

As we approach the decade of the 90s, Army topography is making a transition. Traditional 1:50,000 scale topographic line maps and other standard paper products are no longer produced by the Army. Although the era of the paper or mylar product is ending, special products tailored to meet a particular need of a supported commander will remain for several years to come. Army topography is moving toward an era of information management and away from the era of product management. Digital data bases will eventually replace the present voluminous data base structure of literature, paper products, and miscellaneous materials collected by terrain analysts. Digital information will be maintained to reflect up-to-date battlefield conditions. This information will feed directly into various command, control, communications, and intelligence (C3I) systems and tactical decision aides will synthesize this information with other data to provide commanders with instantaneous analyses of battlefield options.

While neat and tidy on an organization chart, topography ceased to be functionally effective.

The Topographic Support System (TSS), a modular system of 22 large vans that provide traditional topographic services (cartography, survey, reproduction, and terrain analysis) is being replaced, in part, by the Digital Topographic Support System (DTSS) and Quick Response Multicolor Printer (QRMP). DTSS and QRMP will be located with each All-Source Analysis System (ASAS) enclave at Division, Corps, and Echelons above Corps (EAC). The new digital system will automate much of the labor-intensive efforts of the terrain



Position-navigation systems will establish precise positioning on the battlefield.

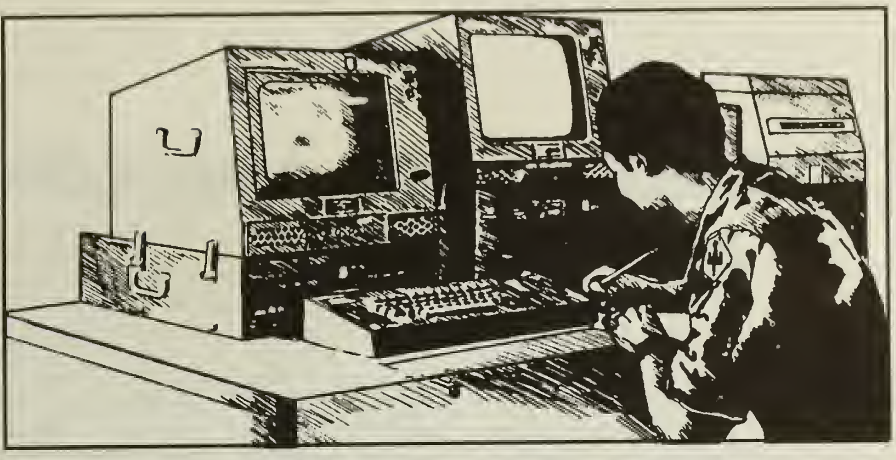
analysts and cartographers. QRMP will reduce reproduction equipment needs on the battlefield. The Army may require bulk printing capability at EAC to provide standard paper products that DMA cannot provide in sufficient quantities or in time to meet theater needs.

Topographic survey appears to be almost obsolete as technology may provide advanced systems with the means to establish its own geodetic control and precise positioning. The surveyor may be relegated to a back-up role on the battlefield of the future, once position-navigation systems have been fielded and accepted. What the force structure will be, what topographic skills, new and old, will be required, and how some of the traditional topographic equipment not replaced by DTSS and QRMP will be distributed on the battlefield are issues to be solved by the new Department of Topography over the next few years.

Perhaps the topography force structure should be considered as part of E-Force? Certainly, it is the intent to have topographic engineers supporting each division, each corps, and back-up support at EAC.

The digital data to support DTSS is a DMA production responsibility and satisfaction of the full Army need may not be until in the late 1990s. During the interim period several off-the-shelf digital systems will provide transitional support. MICROFIX is the present interim system and is supported by DMA-produced Digital Terrain Elevation Data (DTED). Engineer Topographic Laboratories format DTED for Army use. Other systems may require the Army to meet its own interim digital requirements until sufficient Tactical Terrain Data (TTD), the Army's future digital data requirement, are available.

The enlisted strength of Career Management Field (CMF) 81, Topographic Engineering, is approximately 2,000 soldiers distributed throughout the total Army—roughly 1,200 in the active force. These figures are misleading because approximately one-fourth of the photolithographers (MOSs 83E and 83F) are truly in the topographic force structure; the remainder are with Adjutant General and Psychological Operations units. Terrain Analysts (MOS 81Q) make up over one-fourth of the CMF. As the Department of Topography takes the lead in developing force structure and doctrine for the future, this CMF will undergo major revisions.



Digital data bases will reflect up-to-date battlefield conditions.

Army topography programs have deteriorated because the Army lost the responsibility to conduct its own training.

Topography training for skill levels 1 and 3 (AIT and the technical track of BNCOC) are not integrated into the TRADOC system because they are taught by DMS and not the Engineer School. Since the Army has the only topographic force structure on the battlefield (USMC has one topographic platoon with plans for two more), perhaps topography training should revert back to the Army and the engineers. Fort Leonard Wood would be the true center of expertise for engineers if the topography AIT and BNCOC could be relocated to again become part of the Engineer School. The Army has the responsibility for land combat doctrine for all forces and the engineers have the responsibility for topographic doctrine to support land combat. Army topography programs have deteriorated because the Army lost the responsibility to conduct its own training. The training and doctrine developers are without equipment and necessary expertise to ensure that correspondence courses, technical lessons, graphic training aids, soldier training publications, and other TRADOC and Army programs keep pace with requirements and parallel skill with training.

The new Department of Topography holds the key to the future of Army topography. A new department organizational structure with increased emphasis on technical skills goes into effect in FY89. Engineers at all levels are the special staff experts and advisors to commanders on the effective use of terrain. The Department of Topography will make this happen.

LTC Russell O. Reich, Jr., a 1984 graduate of CGSC, holds a Masters degree in Geodetic Science and Photogrammetry from Iowa State University. He served as the Mapping, Charting, and Geodesy Requirements Officer for CINCLANT and JSTPS. Before being designated as the Director, Department of Topography, LTC Reich served as Chief, Office of Academics and Chief, Department of Construction Engineering, DMS, Fort Belvoir.

CAMOUFLAGE AND CONCEALMENT

by MAJ John M. Luchak

On 1 October 1987, the proponency for camouflage returned to the U.S. Army Engineer School after a long absence of several years. A provisional camouflage and concealment office was established to manage the transition and to chart a strategy for the future development of doctrine, training, and materiel.

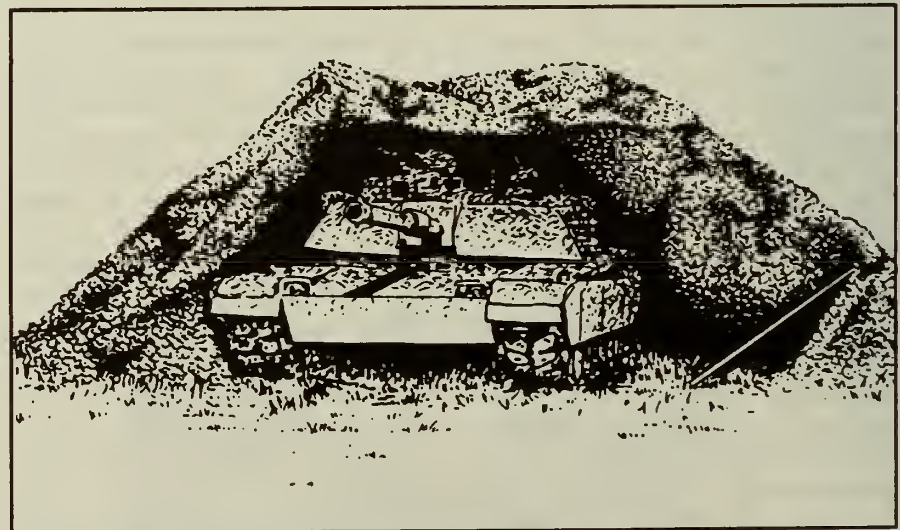
Current camouflage doctrine does not reflect the realities of the AirLand environment of the late 20th century. Indeed, the current field manual, FM 5-28, was published in 1968 and is a product of the Second World War and the Korean War. Today, however, the battlefield is replete with technologically advanced sensors and weapons unimagined in wars past: strategic reconnaissance platforms, smart muitions, and multispectral target acquisition/intelligence systems (UV, IR, acoustic, and radar).

Current training, doctrine, and materiel are no longer effective in adequately countering these systems. Camouflage and concealment doctrine and training must adapt to current realities on the modern battlefield and materiel developments and exploit the technological advances of the past twenty years. They can provide economical, cost-effective solutions which will enable us to neutralize some of these high-cost weapons systems and sensors. The payoff is a significant increase in the survivability of the individual soldier, his equally high-cost weapons systems, and his unit.

The upgrading of camouflage operations requires a two-pronged, short and long-term approach. In the short term, the Engineer School is currently in the process of fielding an updated manual on Army camouflage operations, FM 90-7, *Camouflage and Concealment in Army Operations.* The manual is being written in the Department of Military Engineering at the U.S. Army Engineer School and will provide current doctrine on camouflage. The manual is currently scheduled for publication in FY89. The USAES, in conjunction with the Fort Belvoir Research, Development, and Engineering Center (BRDEC), plan to conduct a series of briefings to inform TRADOC schools and centers about current materiel available to meet the acquisition threat.

Over the long-term, however, a more thorough study of the Army's camouflage requirements is needed. To accomplish this task, the USAES has initiated a study under the support of AR 5-5 to evaluate future camouflage and concealment doctrine, training, materiel, and force structure, based on current threat analysis. The results of this study will necessitate revision of FM 90-7. Doctrinal changes will, result in adjustments to training and, if required, will spur further materiel development to counter the acquisition threat.

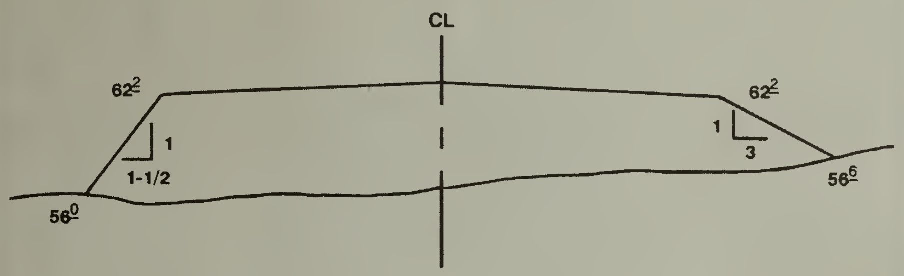
MAJ John M. Luchak is a graduate of the U.S. Military Academy. Commissioned in the Field Artillery, he has served in command and staff positions in Germany and in Korea. MAJ Luchak holds a Master's Degree from the University of Minnesota and a Ph.D in Political Science from the University of Vienna, Austria. Prior to his reassignment to ODCSOPS in the Pentagon, he was the Camouflage and Concealment Coordinator at Fort Belvoir.



Example of an appropriate camouflage net covering a camouflaged item of equipment.

Engineer Problem

You are a platoon leader in a combat heavy battalion deployed in Honduras. You have been tasked to design a CMP culvert to accommodate the runoff of an area measuring 56 acres and composed of GMd soil (with turf). The road which the culvert is to be placed under is a Class A two-lane military road with the following specifications:



Additional information:
There will be no headwall on the downstream end of the culvert. Assume the velocity of water (v) is 4 feet per second. The battalion S4 has advised you of the nestable CMP pipe available:

Pipe Size	Length Available
48″	210′
42″	300′
36″	450′
30″	500′
24″	875′

Your mission is to design a CMP culvert using the battalion S4's constraints.

Engineer Solution on page 27.

ENGINEER SCHOOL MOVE

recent developments at Ft. Leonard Wood

by COL John P. Carey and 1LT(P) Jamie White

"The Engineer School is moving! The Engineer School is moving!" has been the cry at the school since 1977. And, not unlike the boy who cried "wolf!" once too often, we have many skeptics who have fallen asleep. On 15 August 1987, a *boom* was heard throughout the engineer corps that awoke those skeptics. On that day, General Thurman, Commander of TRADOC; Lieutenant General Hieberg, Chief of Engineers; Major General Reno, Commandant, Engineer School; Major General van Loben Sels, Commander, Fort Leonard Wood, and many other military and civilian dignitaries detonated two large explosive charges that marked the spots of the new Academic Building and Post Headquarters.

The first question everyone asks is "Why would the school want to leave Fort Belvoir for Fort Leonard Wood?" The answer is simply to improve engineer training and reduce costs. It is TRADOC's intention to make the United States Army Engineer School and Fort Leonard Wood the mecca for Army engineer training similar to the Armor School at Fort Knox, KY and the Infantry School at Fort Benning, GA.

MG Reno recently stated "Integrated training is the future for Army engineers". Integrated training combines the training of all skill levels. Instead of BNCOC students supervising each other to build a bridge, they will supervise AIT students. This gives the BNCOC student more realistic leadership experience and the AIT student more realistic training while both are training to the same standards. In the long run this will eliminate confusion in the units caused by the officers learning one standard, the NCOs another, and the AIT soldiers a third. Additional synergism will also be gained by collocating all instructors and doctrine writers. This ensures every engineer regardless of rank or position will be trained to the same standard as determined by the subject matter experts who are writing and updating the doctrine.

Fort Leonard Wood was the obvious choice to become the single home of the Engineer School because of its abundant natural training areas and established training facilities. Fort Leonard Wood recently became the Army's recipient, for the second time in three years, of the Department of Defense "Installation of Excellence Award" for 1987. With the completion of the new construction projects, Fort Leonard Wood will undeniably be *the* model training installation within the Army.

The idea that Army engineers require "hands-on field training" is not a new one and is causing history to again repeat itself. Over 70 years ago, Fort Belvoir was chosen as the location for the Engineer School because of its natural engineer training sites. The home of the Engineer School was then located at Washington Barracks (now Fort McNair). As metropolitan Washington D.C. grew and the training requirements for engineers increased it was deemed necessary to move the Engineer School to Camp Humphreys (now Fort Belvoir). As Fort Belvoir can no longer meet the training

The new Post Headquarters Building under construction at Fort Leonard Wood, Missouri.

requirements of the Engineer School because of the urbanization in northern Virginia and the increased training requirements for modern Army engineers, the school must again pack up and move. At present, most of the field training for the Engineer Officer Basic Course is conducted at Fort A. P. Hill, 35 miles away.

Besides reducing the costs of training engineers, there will be an additional cost savings to the government by back-filling Fort Belvoir with DOD organizations that presently pay exorbitant rent for leased office buildings in the D.C. area. The land and facilities at Fort Belvoir have already been requested for use by several DOD agencies (INSCOM, TAPA, AMC, and the Chief of Engineers Office) that are required to be located in the Washington D.C. area. INSCOM has already started construction of a new Central Office on Fort Belvoir where over 1,100 INSCOM personnel will work. At this time, the Secretary of the Army has not decided what other activities will move to Fort Belvoir.

The Commandant of the Engineer School has taken advantage of the transition phase of the school to restructure it to make optimum use of improved training areas and facilities at Fort Leonard Wood. The changes most notable to students will be within the Directorates of Military Engineering and of Combined Arms. Both organizations will be restructured to accommodate more hands-on and field training rather than classroom instruction.

A "Military Operations Short of War" Division is being established as part of the Department of Military Engineering. The focus on this division will be on the doctrine, training, organization, and equipment needed during in low-intensity conflicts.

The Department of Topography was recently established to help the Engineer School more effectively pull together the topographic functions of the Army. It will oversee all topographic training and doctrine within the Engineer School.

The Directorate of Combat Developments, Engineer Personnel Proponency Office, Directorate of Evaluation and Standardization, and the Engineer School Secretary will reorganize to take advantage of modern facilities with state-of-the-art automation and communication systems.

Many new facilities are being constructed to accommodate the Engineer School at Fort Leonard Wood. The Academic Center (Gen. George Lincoln Hall), is being constructed with offices for all instructors and staff, 35 state-of-the-art classrooms, and a Battle Command Training Center which will incorporate the latest technology on battlefield simulation. It will be ready for occupancy by FY89.

The Headquarters Building (Gen. William M. Hoge Hall), will also be completed by October 1989. It will be a modern office building with modular systems furniture. This will allow future commanders great flexibility in reorganizing and restructuring the office. The walls will be prewired for the latest automation and communication equipment.

The General Bruce C. Clarke Library will be completed in November 1989 and will be used as a community library and the Engineer School technical reference library.

The 346 Unaccompanied Officer Quarters (UOQs) will be completed in March 1990. The four-building complex will be known as the General Morelli housing area. The buildings will be named after engineer officers who served gallantly in WWII, Korea, and Vietnam. They will be hard-wired for computers which will be tied into the main frame in Lincoln Hall (academic center). Once the terminals are installed, the students will have the opportunity to work on projects or computer-aided instruction at any time.

The transition of the U.S. Army Engineer School has been an exciting challenge for the many civilian and military personnel who now work there. We believe that the school will have an even more exciting future at Fort Leonard Wood in the next few years.

It is said that a school is judged by the products of its students. The Engineer School at Fort Belvoir has certainly distinguished itself in the past 70 years as its graduates have gone on to distinguish themselves in battle, as well as constructing many impressive civil works projects such as the Panama Canal, Hoover Dam, and the Manhattan Project.

With the improved training areas, facilities, and organization found at The United States Army Engineer Center and Fort Leonard Wood the future of the United States Army Corps of Engineers looks brighter than ever.

(See page 20 for a chronology of events for the Engineer School move to Fort Leonard Wood.)

COL John P. Carey was the Director of the Engineer School Transition Office (ESTO) from July 1987 to August 1988. He is presently the Deputy Commander of the Lower Mississippi Engineer District in Vicksburg, Mississippi. COL Carey's recent assignments include: Commander of the 809th Engineer Battalion and the Director of Evaluation and Standardization prior to coming to ESTO. He has a B.S. in Civil Engineering from Texas Tech, and a Masters in Civil Engineering from George Washington University.

1LT(P) Jamie White was the Operations Officer of ESTO from July 1987 to July 1988. His recent assignments include: Executive Officer of D Company, 1st Battalion, Maintenance Officer of the 30th Engineer Battalion, and Assistant Operations Officer of the 4th Engineer Brigade. He presently works as a Consulting Engineer in northern Virginia. He has a B.S. in Mechanical Engineering from Rose-Hulman Institute of Technology.

Photo by Jennifer C. Bolyard

CHRONOLOGY OF EVENTS TRANSITIONING THE U.S. ARMY ENGINEER SCHOOL FROM FORT BELVOIR, VIRGINIA TO FORT LEONARD WOOD, MISSOURI

Date	Event
1973	TRADOC prepared several feasiblilty studies that consistently supported the concept of moving the school to improve the quality of training while reducing costs.
Feb 1985	Secretary of the Army announced the approval of the plan to relocate the United States Army Engineer School from Fort Belvoir, VA to Fort Leonard Wood, MO.
Summer 1987	BNCOC was moved to the NCO Academy at Fort Leonard Wood.
Apr 1988	All Engineer NCO courses were realigned and located with the NCO Academy at Fort Leonard Wood.
1 Jun 1988	The United States Army Engineer School was officially relocated from Fort Belvoir, VA to Fort Leonard Wood, MO. However, all of the Engineer Officer Courses will still be conducted at Fort Belvoir. Fort Belvoir is officially designated United States Army Fort Belvoir.
Summer 1988	DCD and EPPO as well as parts of DOTD and ESS will relocate to Fort Leonard Wood.
29 Jul 1988	All DML courses (52 series) are redesignated as Ordnance MOSs (Military Organization Skills) and come under control of the U.S. Army Ordnance School and Aberdeen Proving Ground. All courses will continue to be taught at Fort Belvoir.
1 Oct 1988	United States Army Fort Belvoir is officially transferred to the command of the Commanding General, U.S. Army Military District of Washington, Fort Lesley J. McNair, Washington, D.C.
Fall 1988	81B and 82B MOS (construction surveyors and drafters) enlisted courses will move to Leonard Wood.
Jun 1989 -Jan 1990	The remaining staff and faculty will relocate to Fort Leonard Wood depending on their position. Instructors will move after their last class has been taught at Fort Belvoir. However, every effort will be made to move families with school age children during the summer.
Jan 1990	The first Engineer Officer Advanced Course will start at Fort Leonard Wood.
Feb 1990	The first Engineer Officer Basic Course will start at Fort Leonard Wood.

Whatever happened to assault boat crossing ?

by CPT Frank S. Weston, Jr.

When a brigade or division executes a deliberate river crossing, the first phase is an assault across the river. The preferred forms of transportation for the assault troops are helicopters and amphibious vehicles (while not true amphibians, M113, M2/3, and the ACE are included). What if these are not available? At night or in bad weather conditions, helicopters are often grounded. Tracked vehicles are slow, noisy and vulnerable while in the water, and hard to get out of the water on the far bank. Problems with swimming tracks are also well documented in safety bulletins and regulations prohibiting tracks from swimming during training. If we can't swim tracks during training, how do we train for the assault crossing? The only back-up for helicopters or amphibious vehicles is the old reliable 15-man assault boat (RB-15).

To execute the RB-15 assault crossing successfully, the crossing unit must make a detailed plan and conduct good rehearsals. The Egyptians, during their assault crossing of the Suez Canal in the 1973 Arab-Israeli War, had planned their operation for several years and rehearsed hundreds of times. They divided their assault force into waves, while maintaining unit integrity. Commanders were with each wave. So detailed was their plan, that they'd stretched colored ropes across the Canal to ensure that each assaulting unit landed at the right spot on the far bank. They were successful. Because of this need for detailed planning to ensure success, we cannot perform the assault boat crossing as an afterthought, once the helicopters are grounded or the tracks cannot swim. Engineers are the experts in assault boat crossing and should have the training and expertise to plan the operation. But what has happened to the assault boat crossing in current Army doctrine? We seem to have forgotten to include it in our "how to" manuals. FM 90-13, *River Crossing Operations*; TM 5-210, *Military Float Bridge Equipment*; and FC 90-13, *Counterobstacle and River Crossing Operations*, tell us to expect to do an RB-15 crossing, but not how to sucessfully execute it.

When presented with the task of writing how to organize and execute an assault boat crossing, rather than "reinventing the wheel", we decided to find historical examples of successful assault crossings, using World War II as the primary source. ST 5-260-1B, *Military River Crossing Equipment*, 1959, found in the U.S. Army Engineer School Library, provided this excerpt:

Boats are unloaded from transportation by the engineer crews and located either in the attack position or at an intermediate boat area between the attack position and the river. The ideal attack position will be accessible to trucks or carrying parties bringing up the assault boats, concealed from hostile ground fire and aerial observation, connected to the river's edge by numerous clearly defined foot routes, close to the river to reduce hand-carrying by infantry to a minimum, and easy to identify at night.

Guides from the engineer assault boat teams meet infantry units as they enter the attack positions and guide them to their respective boats. Assault boats are hand-carried by the infantry-engineer teams to the river over concealed routes.

At the designated time, the first assault wave moves forward to cross the line of departure at H-hour. Assault boats promptly return to the near bank when each trip is completed, and the crossing of subsequent waves proceeds as soon as the boats are loaded. Boats leave from the same near-bank area and proceed to the same far-bank area on each trip.

Close cooperation between infantry and engineers in the assault is essential. The senior infantryman in each boat team is responsible for all the technical aspects of loading, crossing, and unloading his boat. He is also responsible for assisting the boat commander in these operations. When the far bank is reached, infantry boat teams disembark promptly, deploy, and move forward into the attack or to a rallying area where units quickly reorganize and advance to their objective.

Another manual, ROTC ST 45-5, *River Crossing Operation*, 1953, featured diagrams showing how companies move from the battalion assembly area into attack positions, where they are separated into waves.

All of the information from the 1953 and 1959 manuals still applies to the modern day AirLand battlefield. To get this information back into our manuals, we need make only small changes to reflect modern organizations. In bringing back the "how to" for assault boat crossings, we have looked to the past to provide for the future.

CPT Frank S. Weston, Jr. is an instructor in the Department of Combined Arms, U.S. Army Engineer School. He has also served as platoon leader, company executive officer, and battalion S2 with the 4th Engineer Battalion, 4th Infantry Division (Mech.). CPT Weston graduated from USMA in 1982, and is a graduate of EODAC and CAS3.

CONDUCTING A STAFF RIDE

by CPT Donald D. Jacobovitz

Staff rides are detailed analyses of historical battles or campaigns with the intention of allowing the participant to evaluate the actions and decisions of the units involved. They are becoming more popular as an important part of professional development programs throughout the Army. Often, someone is tasked to plan and execute a staff ride with little experience or guidance. The Department of Combined Arms at the Engineer School at Fort Belvoir has been conducting staff rides for the staff and faculty for many years.

This article is presented as a guide to those conducting their first staff ride—those who have already directed a staff ride may also benefit from this article. The first question someone asks is, "What is a staff ride?" Next, they want to know what to do. Asking other units what they have done at their staff rides is a good place to begin. William G. Robertson's *The Staff Ride,* published by the United States Army Center of Military History, is a valuable reference to guide the staff ride planner through the steps involved in conducting a successful ride. This article starts where that booklet ends, namely in describing the nuts-and-bolts of the staff ride.

As Robertson's booklet points out, picking the proper place for a staff ride is important. It should have the historical elements which you need for instruction, and must be logistically supportable. Choose a site that meets your needs.

When the location for the staff ride is determined, contact the National Park Service (NPS) or local officials at the battlefield and arrange a visit. This should be done no later than ten to twelve weeks prior to the date of the staff ride.

Visit the site to get an understanding of the extent of the battle. Visit the local military or public library and get material on the battle or campaign. Read these references to get a basic knowledge of the battle, and gather references for the participants to read. Consider sources other than the libraries such as local Civil War Roundtable groups, the Center of Military History or the historians at the Office of the Chief of Engineers.

Next, choose one book for all the staff ride participants to read. This will provide a common basis from which to discuss the events of the battle. Order the books in sufficient quantities so that all participants will be able to read them prior to the event.

Maps of the battlefield may be ordered through local map supply channels or locally purchased through the U.S. Geological Survey or NPS. Maps of 1:25,000 scale or smaller are preferred for these historical studies. Order these maps and any other booklets, folders, etc. far enough in advance so they arrive in time for use on the staff ride.

Choose the date for the staff ride at least eight weeks before it is scheduled. Select dates for prebriefs before the actual staff ride. Coordinate with all those involved with the ride so a date can be selected that will allow maximum participation. Transportation requests should be submitted no later than four weeks prior to the event.

After researching the battle, write a proposed itinerary consisting of the events on the day of the staff ride and the prebriefs. These should be shown to the NPS or other historians for approval to ensure that your itineraries are meaningful, complete, and able to be completed to the extent desired and in time allotted. Reserve classrooms or auditoriums (including audiovisual equipment) in advance of your prebriefs.

Coordinate with members of the chain of command on the staff ride proposals. Once you have approved dates for your prebriefs and for the staff ride itself, make up a flyer and send it to all prospective participants and post it on bulletin boards. Make sure it contains all pertinent information such as the time, place, sign-up information and point of contact for the trip. Make announcements in the local daily bulletin and post and unit newspapers.

Prepare information packets (folders) for the staff ride participants containing material such as a letter of introduction, maps, battlefield brochures, bibliography list, a battle analysis format and articles about the battle to be studied.

Local dignitaries or other officers outside of your organization may be invited to attend the event. Send letters of invitation to them no later than four weeks before your first meeting.

At this time, arrange for guest speakers to speak at your prebriefs. Post, local or branch historians usually do this quite well when requested. Obtain slides and films of some of the more well-known battlefields that can be shown during the prebriefs.

When conducting the reconnaissance, coordinate with the officials at the site for access to the site, your itinerary, and site preparations. During one of our staff rides, we had the NPS work together with a colonial reenactor to portray a Continental soldier. He told the group about the life and times of the soldiers during the Revolutionary War. We have also had an actor portray President Lincoln at Gettysburg, PA, during our after-action review.

Write a final letter of instruction for each of the staff ride participants, spelling out their responsibilities and giving them all the administrative instructions they need to know. Distribute this information as soon as possible. Each participant should be asked to prepare a short talk or presentation about a topic concerning the battle. This gets everyone involved and eliminates the need to study the whole battle in detail.

Compile a list of the participants including their names, ranks, SSNs (if aircraft flights are involved), office phone numbers and distribution stop numbers or office designations. This will help in getting information out to all participants in a timely manner. Assign group leaders and divide the participants into smaller groups (5-15 members) in which they will study the battle. When the staff ride begins, these smaller groups can rejoin the main group. They can then share their research with the other participants.

Conduct the prebriefs at one a week for three or four weeks before the trip. This gives the participants time to prepare for the discussions they will be leading. When possible, the individual group leaders should attend the reconnaissance of the battlefield. This will enable them to better lead their group's discussions. End the sign-up for the staff ride at the first prebrief because after this point, participants may not have enough time to adequately prepare.

Organize the supplies needed. Collect and have readily available two or three days before the trip the following items: water cans or jugs, paper cups, trash bags, binoculars, radios, etc. Assign responsibility for all items to preclude loss or damage.

The staff ride should start at the visitor center with a general orientation of the terrain and an overview of the battle in the form of a short lecture, slide show, or film.

The staff ride itself can be walked, ridden in buses, or flown in helicopters with equal success. However, the participants will get the most out of the staff ride if they walk it as much as possible. When using helicopters, ensure that there are enough headsets for each participant to hear the leader's presentation. Helicopters should not be used as a replacement for other vehicles, but should be used as a resourse to give them a perspective they would otherwise not receive.

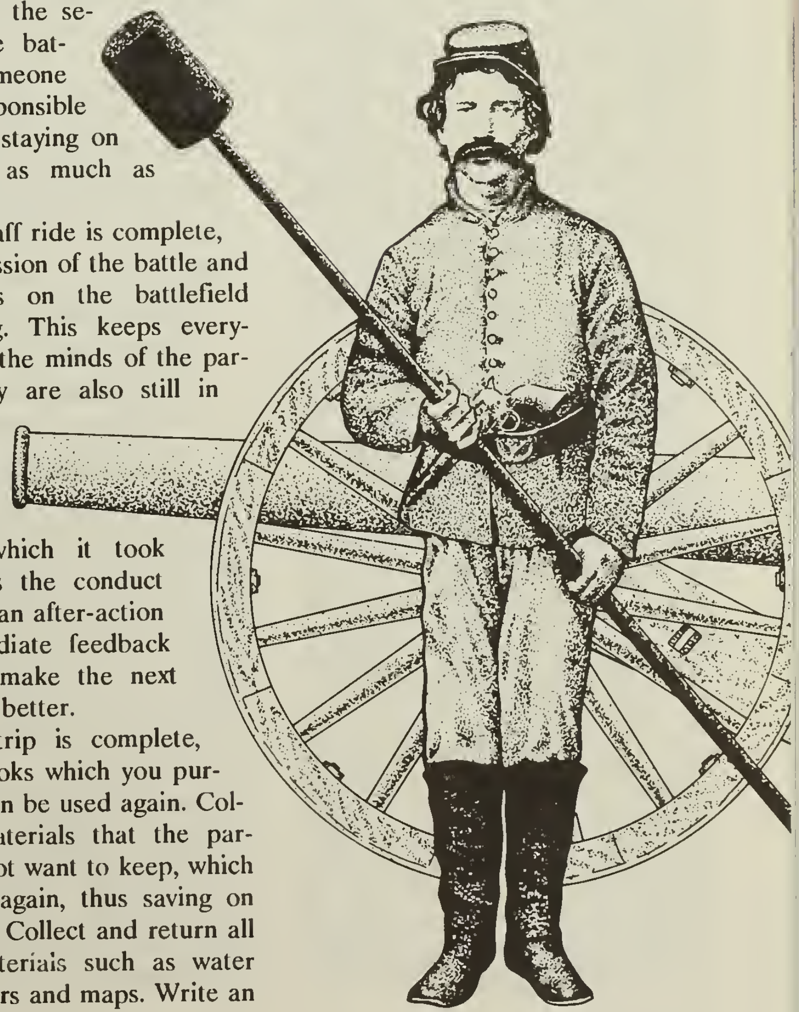
Design the stands around the battlefield so that the participants see all major terrain covered during the battle. Plan the sequence of stands so they follow the sequence of the battle. Also, someone should be responsible for the group staying on the schedule as much as possible.

After the staff ride is complete, wrap up discussion of the battle and of the events on the battlefield before leaving. This keeps everything fresh in the minds of the participants. They are also still in the spirit of the battle by being there on the ground on which it took place. Discuss the conduct of the ride in an after-action review. Immediate feedback will help to make the next staff ride even better.

Once the trip is complete, collect the books which you purchased that can be used again. Collect other materials that the participants do not want to keep, which can be used again, thus saving on copying costs. Collect and return all borrowed materials such as water cans, binoculars and maps. Write an after-action report about the trip that can be used by the next staff ride coordinator.

There are many personnel and agencies to assist you in organizing a staff ride. Each staff ride you conduct will improve over those before it. The rides will contribute immeasurably to the professional development of those involved. If you follow these guidelines and have a good time, you will have a successful staff ride.

CPT Donald D. Jacobovitz, was an instructor in the Leadership Branch of the Engineer School at Fort Belvoir. He is a 1977 graduate of West Point, and has served in Germany and Korea, and commanded at Fort Carson, CO. While at the Engineer School, he has led the staff and faculty of the Engineer School on staff rides to Antietam, Gettysburg, Yorktown, Manassas, and Fredericksburg.



REALISTIC TRAINING ON A BUDGET:

by LTC Arthur A. Marubbio, Jr.

You would be hard pressed to find a Department of Defense employee unaffected by the current round of budgetary cutbacks. Although everyone can relate to reduced expenditures within the services, the one person who is most severely affected is the soldier on the ground. Ultimately, they are the recipients of our successes and failures, and their level of training can make the difference between winning and losing on the battlefield of the future. The real question becomes "How can we best train our soldiers with the least resources and still achieve a level of training that will allow them to survive and win on the battlefield of the future?"

Engineers have not historically been major consumers of resources in the training environment as compared to other Combined Arms team members. Unfortunately, this can be directly related to a reduced level of realism in the conduct of many of our engineer missions. Even today, it is not uncommon to go to the National Training Center and find slices of logs representing mines in a minefield. Additionally, since we must compete for training ammunition and dollars, we have never been able to achieve the level of demolition training needed to truly train and sustain our engineers to a level of proficiency necessary for total mission success.

If we are to achieve success on the AirLand battlefield, all soldiers must have the proper training in not only the "tools of their trade" but also in the effects that those tools will ultimately produce. Unfortunately, these tools cost money which is becoming increasingly difficult to obtain. The only apparent solution to this dilemma is the prudent use of training aids or devices that provide effective training, produce realistic effects and cost substantially less than the items they are intended to replicate. Engineer training devices are necessary for the accomplishment of our training mission.

...we have never been able to achieve the level of demolition training needed to truly train and sustain our engineers to a level of proficiency necessary for total mission success.

Training Devices For Use In Landmine Warfare

The Engineer School developed a training mine strategy in 1982 and refined that strategy in 1986. This strategy encompassed training from the individual soldier level through the force-on-force, combined arms exercise. Although our doctrinal strategy for the emplacement of mines has been updated, the hardware used to support this strategy has not changed substantially since World War II. Additionally, the devices used to train mine warfare skills are also of World War II vintage and have been all but depleted. Based on this shortfall, a total revamping of the mine warfare device inventory was required. After careful evaluation of the training needs of our soldiers, it was determined that realistic replicas of current service mines were required to teach and sustain placement, arming and disarming skills associated with hand-emplaced minefields. This was considered to be Level I of the overall strategy and the solution was the development of the Placed Training Mine Kit (PTM).

The PTM consists of plastic replicas of six U.S. service mines and five antihandling devices, packaged in a reinforced container used for storage and shipping. These reusable mines are specifically designed to teach all soldier skills associated with the emplacement, arming and disarming of current landmines. Additionally, a safe, audible response will be provided to the soldier in the event that improper procedures are used in the

THE DEVICE SOLUTION

arming/disarming sequence. This kit is intended for both institutional and unit training, but is not for use in the emplacement of training mine fields. The PTM is currently being produced and will be fielded to all units requiring landmine training. Additional kits will be available, through supporting TASCs, for use by units not designated on the current distribution list.

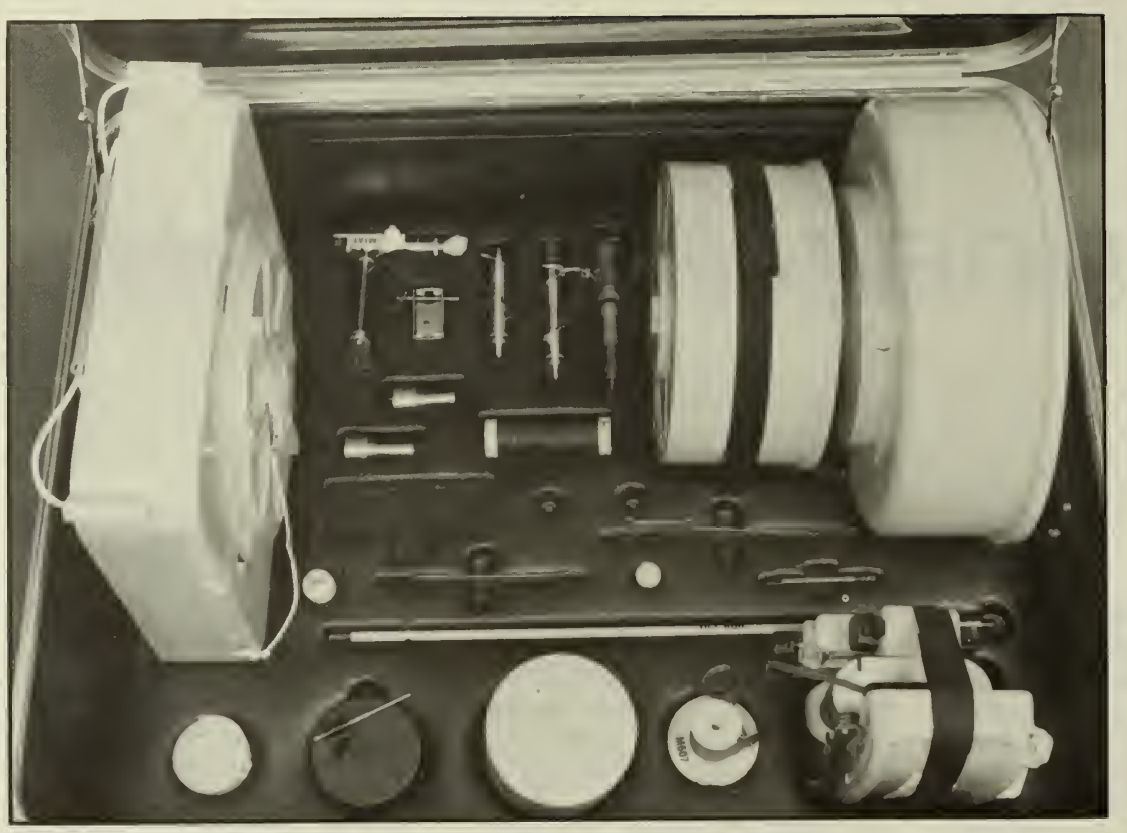
Level II of the mine warfare strategy includes collective training at both local training areas and at major training centers such as NTC and the CTC. At this level of training, the effects of a mine detonation must be realistically replicated so as to achieve a level of training which will allow for the successful breaching of a threat minefield. These effects must be realistic and incorporate both the visual cues of flash and smoke as well as an appropriate interface which will disable vehicles and personnel through the MILES system. In response to this need, the Jet Propulsion Laboratories (JPL) developed the Mine Effects Simulator (MES), a system related to the Field Artillery School's program known as the Simulation of Area Weapons Effects (SAWE). The MES consists of two generic mines (antitank and antipersonnel) which closely resemble the size, weight and arming sequence of current service mines. Both mines will produce a warning whistle prior to detonation, as well as smoke and flash. Additionally, the mines, when detonated, will produce a high frequency signal which interacts, through a Player/Vehicle Detector Device (PDD or VDD), with the MILES system. "Probabilities of kill" will be incorporated into the PDD/VDD to match the level of survivability of the affected person or system. The actual development of the mines themselves has been completed and the PDD/VDD is currently entering the initial development stages. Actual fielding of the MES is expected in the early 1990s with priority to the MTCs.

Both mines will produce a warning whistle prior to detonation, as well as smoke and flash.

The Level III portion of the training mine strategy is the development of other training mines/training mine systems which support the family of scatterable mines and other special applications. Although training mines have been developed to support both MOPMS and Volcano, these training mines are far too expensive to support combined arms exercises and they do not produce desired battlefield effects.

Additionally, an effort was initiated to determine the feasibility of developing a cost-effective, realistic device to replicate, at a minimum, the effects of FASCAM and if possible, the delivery of this type of minefield. Based on recent cutbacks in the funding of Army Training Devices, this entire program has been eliminated. The good news is that the replication of FASCAM-type minefields has a potential solution in two other ongoing initiatives. The first, and most timely, solution is the upgrade to the current instrumentation system at the National Training Center. Incorporated into this system will be the ability to designate minefields electronically on the ground with basic "kill data" being provided back to the control facility based on entry into the minefield. The obvious drawback to this approach is the lack of any audio/visual cues to enhance realism on the ground.

The second initiative involves the SAWE program. Although still in development, this system can replicate area-type minefields, similar to a FASCAM, and provide realistic feedback through MILES interface. The type and degree of audio/visual cues is still being discussed and the acceptance of this system for other than field artillery use is



The Placed Training Mine Kit contains plastic replicas of six U.S. service mines and five antihandling devices, packaged in a reinforced container.

yet to be resolved. Although a Level III solution is on the horizon, substantial follow-up coordination will be required to solidify this solution.

Other Engineer Training Devices

The Combat Engineer Vehicle (CEV) has always posed a gunnery training problem for the engineer community due to both expense and availability of ranges. Two support systems, that have been under development for several years, should increase CEV gunner proficiency. The first device is the videodisc *Gunnery Trainer* (CEV VIGS). This trainer will allow gunners to train, without the CEV, in the skills necessary to identify and properly engage a typical demolition target. The contract for this system has been awarded and the first trainers are expected to be on the ground by the end of FY88.

The second phase of this CEV gunnery training system is the CEV Subcaliber Device. This device uses an exact replica of the 165mm demolition round and houses a firing mechanism for a 40mm round. This device will teach both crew and individual gunnery skills, at a reduced cost, and on smaller ranges. The combination of these two systems will increase crew proficiency, reduce ammunition and maintenance expenditures and provide the training necessary to achieve qualification standards for CEV gunners.

The last training device currently in production is the M270, Cratering Munition, which replicates the size, shape, weight, and emplacement characteristics of the M-180 Cratering Munition. This device is an Army-developed and-produced system, which went from concept to production in under 6 months, using TASC-available technology. Once completed, the system will allow unrestricted training of emplacement, wiring and firing of this munition, at any location, and without the safety risks of the live system. This device will not only save the Army money—it will also save lives.

Training in a constrained environment requires detailed planning, dedicated leadership, and training devices that can replicate the characteristics and effects of the system to be trained. The current strategy for training mine warfare and demolition skills is realistic and will support the needs of both the Army leadership and the soldiers in the field. This multilevel approach will not only enhance engineer training, but, more importantly, will realistically train the total combined arms community.

LTC Arthur A. Mambbio, Jr., served as Chief of the Engineer School's New Equipment Systems Division before assuming the duties of the Deputy Director of the Directorate of Training and Doctrine, United States Army Engineer School, Fort Belvoir, VA.

Engineer Solution

Utilize the Field Estimate method of determining runoff:

$$Q = 2ARC$$

Where Q = Peak volume of runoff in cubic feet/second
2 = A constant
A = Area in acres (56 acres)
R = Design rainfall intensity (Honduras = 2.5″ per hour) Page 2-9, FM 5-335
C = Runoff to rainfall coefficient (GMd soil w/turf = 0.30)

$$\text{Therefore, } Q = 2(56)\ (2.5)\ (0.30)$$
$$= 84 \text{ cubic feet/second}$$

Apply the Continuity Equation, $Q = VA_w$ where $V = 4$ feet per second to obtain A_w.

$$A_w = \frac{Q}{4} = \frac{84 \text{ cfs}}{4 \text{ fps}} = 21 \text{ square feet}$$

Obtain A_{design}; $A_{des} = 2\,A_w$
$A_{des} = 2\ (21 \text{ sf})$
$A_{des} = 42 \text{ sf}$

From the road specifications, $F_{minimum}$ is 5.6 feet (62.2-56.6). The maximum pipe size diameter is (2/3) (F_{min}).

$$D_{max} = (2/3)\ (5.6 \text{ feet})$$
$$= 3.73 \text{ feet}$$

In inches: 3.73 (12 inches/foot) = 44.8 inches

Engineer Solution

D_{max} is 44.8 inches but a 44.8 inch CMP culvert is not a commonly stocked culvert, so the nearest smaller available pipe is selected as D_{max}. From page 4-6, FM 5-335, a 42 inch CMP culvert is selected.

Calculate the number of pipes:

$$N_{pipe\ (42'')} = \frac{A_{des}}{A_{pipe}} = \frac{42\text{ sf}}{9.62\text{ sf}} = 4.3\text{ pipes, or 5 pipes}$$

Check the next smaller pipe size to see if the number of pipes increases. This should be repeated successively using smaller pipes until the most economical solution is determined. The most economical solution would be the least number of pipes with the smallest diameter:

$$N_{pipe\ (36'')} = \frac{A_{des}}{A_{pipe}} = \frac{42\text{ sf}}{7.07\text{ sf}} = 5.94\text{ pipes, or 6 pipes}$$

Use five 42-inch pipes since it is more economical to use the smaller pipe with the least number of pipes.

Calculate the Length of Place (LIP) of a pipe:

The width of a Class A two-lane military road with shoulders is 32 feet (See TM 5-302). On the left, the fill slope is 1-1/2: 1,with a depth of 6.2 feet. On the right side, the side slope is 3:1 with a depth of 5.6 feet. This results in a culvert length of (1-1/2 x 6.2′) + 32 feet + (3 x 5.6′) = 58.1 feet.

Since a headwall is not to be constructed on the downstream end of the culvert, extend the culvert an additional 2 feet to prevent erosion of the fill. This makes the length = 58.1′ + 2″ = 60.1 feet. Round up to the nearest even number since nestable CMP culvert comes in 2-foot effective lengths. Thus, the LIP for a pipe is 62 feet.

Engineer Solution

Next, calculate the Order Length (OL) of the culverts. Multiply the LIP by the N_{pipes} and add an additional 15% to allow for loss:

$$\begin{aligned} \text{OL} &= \text{LIP} \times N_{\text{pipe}} \times 1.15 \\ &= 62' \times 5 \times 1.15 \\ &= 356.5' \end{aligned}$$

Round up to the nearest even number:

$$= 358'$$

Looking at the Battalion S4 constraints, there is not enough 42″ culvert available. Since the 42″ pipe is the maximum pipe size, the 48″ pipe cannot be considered. Calculate the OL for the next smaller available pipe, 36″ (**Note**: the LIP does not change):

$$\begin{aligned} \text{OL} &= 62' \times 6 \times 1.15 \\ &= 427.8' \end{aligned}$$

Round up to the nearest even number:

$$= 428'$$

The S4 has 450′ of 36″ CMP; therefore, this is the solution.

This problem was submitted by CPT Cal S. Matsumoto and CPT Edward P. Boyajian, instructors with the Horizcntal Construction Section, Roads and Airfields Branch, Dept. of Military Engineering, U.S. Army Engineer School.

BUILDING STRONG ROADS

hands-on training in Fuertes Caminos-'88 Honduras

by CPT Roy W. Rieder

"Gentlemen, this is not a training exercise. This is an operation as real as any operation ever performed in combat." These were the first words heard by the staff of the U.S. Army, Fort Meade, MD, in connection with Fuertes Caminos-'88 Honduras, the successor to the Blazing Trails exercises.

About 7,500 Reserve Component soldiers worked on the road from November 1987 to June 1988, both in engineering and support roles.

The road was constructed in a mountainous region between the town of Yoro and the village of Jacon. The elevation varied from 400 meters at Jacon to 1100 meters at the quarry, three kilometers from the start of the new road.

The mission, at first, was to construct 5.5 kilometers of new road in the Yoro province in northern-central Honduras. This was later expanded to 11.5 kilometers and the reconstruction of 2.5 kilometers of road from Blazing Trails '87.

As originally designed by SECOPT, the Honduran equivalent of our Department of Transportation, the road would have followed a ridge line passing north of the village of Jacon where it was to join the Cabonis Trail. This route cuts through 30 meters of limestone in some areas. An alternate route was found, slightly longer than the SECOPT design, but was easier to construct because deep cuts through rock were avoided.

The road was divided into nine worksites; seven on the new road and two on the '87 road. Seven sites would be worked simultaneously beginning with the '87 road. The last two sites on the new road near Jacon were considered to be easily done and would be saved for last.

Task Force 111, West Virginia National Guard, was selected to oversee the project. It was required to establish and operate a quarry which would produce over 29,000 cubic meters of approximately two-inch stone.

The terrain was so difficult, the Honduran sergeants major argued over who would get the honor of making the first, and most dangerous cut.

A base camp, to house and support the engineers during the road construction, and six access roads to the worksites and the quarry were also built.

The construction of the road had some unique characteristics. The terrain was steep, with drops of 150 meters in several areas. Some fill slopes had to be modified to avoid placing the toe of the slope more than 1,000 meters out from the centerline.

At one culvert site, the fill on the right toe was 37 meters. The Honduran engineers made the largest cut—a sidehill cut of about 30 meters. The terrain was so difficult, the Honduran sergeants major argued over who would get the honor of making the first, and most dangerous cut.

Two active component engineer battalions and one engineer company were selected to assist the task force. The 52d Engineer Battalion from Fort Carson, CO, constructed the base camp and the access roads prior to the arrival of the main body of Task Force 111. The 92d Engineer Battalion, from Forts Stewart and Gordon, GA, worked with the task force on the road itself.

The 13th Engineer Company (Construction Support), from Fort Knox, KY, established and ran the quarry and provided technical expertise and supervision for all demolition operations. The Honduran Armed Forces provided soldiers from their 1st Engineer Battalion to work on the road.

Another aspect of the construction was the integrated composition of the task force. Because of the distance from the United States to Honduras, it became clear that the task force could not afford the loss of construction time it would experience every two weeks—as all National

First Army engineers construct a stone masonry headwall at culvert #38 of the road.

Facing the headwall of the quarry site, material is moved from one place to another. About 29,000 cubic meters of stone was crushed for the road-building.

Guardsmen and reservists rotated in for annual training.

Not only were American National Guard and Reserves working with active component soldiers as one Army, but the Honduran soldiers worked alongside the Americans.

During the planning of the road, serious consideration was given to the types of equipment used. The task force decided to use D8 dozers extensively. Previously, D7 dozers were used and were required to do extensive blasting in the schist which lies below the surface. With their greatest drawbar pull, the D8s were able to rip the schist avoiding a great deal of blasting.

Despite using the heavy dozers, the task force knew that a significant amount of drilling and blasting would still be required. The staff estimated that 12 rock drills were needed in view of the long lead time to obtain repair parts. After contacting the Engineer School and the Quarry Operator's Course at Fort Leonard Wood, MO, the staff determined that relying on the standard military rock drill was unwise and obtained approval to lease five self-contained rock drills from a commercial vendor. The task force leased a 200 TPH crusher and used two 75 TPH sets as backups.

Another unique aspect in the construction of the road was the use of Army aviation. Due to the isolation of some of the work sites, it was difficult to bring in water and construction materials.

The Colorado National Guard assisted by lending a 200-gallon water bucket used to fight forest fires. A UH-1H helicopter used the bucket to drop water on remote areas of the road for compaction where water distributors had a difficult time gaining access.

The UH-1H was also used to haul 24-inch reinforced concrete pipe with a long sling to the worksites where access was difficult. Transporting the 60- and 48-inch culvert sections on five-ton dumps proved to be dangerous, and larger trucks could not negotiate the winding trails leading to the worksite. The the larger sections were transported by CH-47s from Joint Task Force Bravo at Palmerola Air Base.

Another unique aspect of the exercise was going through a new learning curve with every rotation. By the time the soldiers actually learned their jobs, there were only a few days remaining in country before their annual training was over. This is where the active component soldiers and Honduran engineers became the key to success since they only needed to learn the standards one time.

Not only were there American National Guard and Reserves working with active component soldiers as one Army, but the Honduran soldiers worked side by side the Americans.

The 92d Engineer Battalion took advantage of the rotation weekends by using the equipment allocated to the Reserve Component engineers.

Every operator available manned a piece of equipment—from the newest soldier just out of AIT to the platoon sergeant. The results obtained in these two days were staggering—up to 3,000 cubic meters of soil were excavated, hauled and compacted in one day.

Fuertes Caminos was truly an operation and a training exercise on the largest scale. Soldiers received intensive hands-on training in their MOS, officers and NCOs saw the results of proper planning and tack organization for their missions. Leaders learned how to coordinate with support activities, and soldiers of all ranks developed a better understanding and appreciation for the people of Honduras.

The local Hondurans benefited most of all. The farm-to-market road reduced a four-day journey, on foot, to two days, giving them access to markets, medical care and a better way of life.

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THE IMPORTANCE OF PRACTICING BATTLE DRILLS

by CPT Edward C. Cardon

The following article, published in the June 1988, issue of Army Magazine *is reprinted here with permission. It is essential reading for every engineer leader, and an excellent articulation of what many of you intuitively know: that battle drills—the bridge between individual and collective tasks—are vital to battlefield success. Many engineer units have written drills for their own use, and I commend them for it. We at the School have collected much of that work to aid in preparing drills standard throughout the Army. I am committed to producing a set of proven drills, as quickly as possible, that focus on supporting the combined arms team well forward in the battle.*

MG Daniel R. Schroeder
Commandant

While no one is so naive as to believe a football team in league competition is anything like a combined arms team in a combat environment, certain analogies can be drawn.

Like combat, the mission of a football team is to win. Members of professional football teams are full-time players. Little time is allowed in the huddle to organize a play. To minimize time spent in the huddle, each team enters the playing field with a game plan, a set of plays. Each play has been carefully rehearsed and is, in effect, a drill. At the beginning of the season, a player is assigned a position or positions and a playbook. Each player is expected to know what he has to do on every play in the playbook. Football practice is oriented toward practicing different plays.

The concept behind battle drills is similar to that of professional football. For every mission at the small-unit level, there is an infinite variety of tactical situations; however, some tasks within each mission are the same for any situation. These tasks are best rehearsed and executed using battle drills. Each battle drill, or task, is made up of subtasks. Like football, each subtask must be accomplished for the drill to work. In a battle drill, every squad member knows exactly which subtasks he must accomplish at each moment.

Why use battle drills? The nature of combat, especially first battle, is that units do well only those things that have been ingrained into their activities. There is little time to plan a play in the huddle or train soldiers on each subtask. Drills are ideal and essential in surmounting the nature of combat operations.

Do battle drills work? During a recent exercise at Wildflecken Training Area, West Germany, 21 combat engineer squads were evaluated using standard drills. Each squad was graded using standard drill procedures with a sliding time scale. The standard drills evaluated were as follows:

- Install a hasty road crater.
- Install a wire roadblock.
- Install a hasty row minefield.
- Install a point minefield.
- Breach a Warsaw Pact minefield.

As expected, the squads who trained using drills did much better than squads who "tried to put the play together on the ground." For example, some squads installed a five-hole hasty road crater with live explosives in less than 30 minutes; some squads took more than 60 minutes. What made the difference? Squads that trained using standard drills only needed the obstacle or breach location. Once the location was determined, the squad knew what to do. Squads that trained without using standard drills spent a significant portion of the allotted time figuring out how they were going to complete the specific subtasks of the mission.

Drills affect the time available to a squad leader. The leader of a squad trained in battle drills has time for troop-leading procedures, caring for soldiers and planning for the next mission. The leader of a squad not trained in battle drills seems to spend most of his time organizing, directing and supervising the squad on each subtask within the drill.

That drills are important is easily stated, but we suffer from a lack of momentum, because some people think drills inhibit the initiative of leaders. This is not true. A quarterback, the leader of a football team, assesses the situation and reads the defense. A squad leader assesses the tactical situation. The quarterback calls the play and executes it with precision. If a play becomes "broken," the quarterback uses his initiative to get the job done. The squad leader must do the same.

Executing a battle drill requiring seven soldiers demands initiative if the squad leader has only four. Actually, a battle drill does not rob the squad leader of initiative: it saves the squad leader's energies and time for troop leading tasks. Leaders need to ensure that equipment is

*U.S. Government Printing Office 1988 655-368

operational, rehearsals have been conducted, sufficient sleep and nourishment have been provided, supplies are on hand and that soldiers get to the right spot at the right time – trained, fit and motivated to succeed – even in the face of injury or death.

Battle drills are obviously needed. Just as a football team develops plays for its playbook, an army unit must develop drills for its playbook.

Before developing battle drills, the following questions must be addressed. Which tasks should be battle drills? What is the standard squad? What is the minimum number of soldiers required for the drill to work? What assumptions will be made for security? What is the standard load plan for the squad vehicle? The answers to these and other questions can be used to develop drills at the squad level.

After squad-level drills are developed, each unit should develop platoon-level drills, company-level drills and battalion-level drills. Hence, each unit will have a playbook for each level of command.

Developing drills is not enough. Some football teams have great plays but poor execution. Great football teams execute their plays perfectly. Why? Practice. This same logic applies to the Army.

For drills to serve their intended purpose, they must be practiced. This applies to drills at each level in the chain of command. The drills must be in such detail that each soldier or unit knows exactly what to do at what time. A matrix format that shows each element's subtask for each step of the drill works best. It is important that each level of drill be trained before advancing to the next level. For example, an armor company practicing maneuver drills at the company level is wasting time if the platoons have not mastered their maneuver drills.

As expected, the squads who trained using drills did much better than squads who "tried to put the play together on the ground."

Football teams have special teams for special events. The Army also needs special teams or combined arms drills. Complex obstacle breaching and river crossings are two examples of combined arms drills. Once again, it is important that each unit in the operation be proficient in its drill before attempting a combined arms drill.

In combat, there will be little time in the huddle to design a play or put the parts together to accomplish the mission. The winner will be the unit that can execute each play of the game plan better and faster than its opponent.

If we have a playbook for tasks at each level of command and we train using the playbook, we will win. There will be no need for a long huddle. Each soldier or unit will know exactly what to do and when to do it. Hence, drills can make every soldier and unit a better combat multiplier for the combined arms team.

CPT Edward C. Cardon, commissioned in 1982 from the U.S. Military Academy in the Corps of Engineers, is operations and training officer to the 23rd Battalion in West Germany. He has also served as a platoon leader and battalion maintenance officer in the 17th Engineer Battalion at Ft. Hood, TX, and as assistant training officer for the 130th Engineer Brigade in West Germany.

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THINKING AND FIELDING HIGH TECHNOLOGY

by Dr. Robert A. Sickler

There are people who refuse to accept our nation's role as guardian of capitalism, but history has cast us in this role and it is one we are destined to follow. What other nation has its origin so tied to the fundamentals of individual liberty and universal justice as does the United States? Is there another nation that can display a history steeped in the continuing pursuit of individual freedom and the right to seek for oneself a lifestyle free from the shackles of an oppressive government? The American people love freedom. We fought a bitter Civil War so that our flag might fly over a land united in an effort to bring freedom to all mankind. Any nation with a past so dedicated to freedom must be willing to accept its international responsibilities, and it must possess the strength to carry out that role.

Just as America is the symbol of individual freedom and civil liberty, the Soviet Union stands for oppression of people and subjugation of the individual. When comparing the two countries, one must not believe that government policy always reflects the attitude of the people accurately. In reality, each country is manipulated by a governing body, a body often obsessed with the propagation of an ideology only dimly understood by the people. This governing body sets national policy and controls the armies that enforce and expand that policy. National ideology, whether from the people as in America, or forced on the people as in the Soviet Union, is a major factor in international relations.

Where the ideologies of two nations are antipodal, those nations will be in a continual state of opposition. Conflict between them may manifest itself in high intensity combat between armies. It may be low intensity conflict between surrogate nations; or it may occur as verbal assault. But, there will be conflict. The nation with the stoutest will, greatest resources, and strongest army will be in a position to exert its influence and ideology across the world stage.

Historically, some of the most significant advancements in military strength were a result of innovations in science and technology. Time has proven, however, that technology in and of itself is not the answer. The optimum employment of any technology is realized only when both the developer and the user understand the technology. To know that a technology exists is not the same as understanding it, and you cannot understand a technology unless you think in terms of that technology.

Today the U.S. Army Materiel Command is developing revolutionary technology that will drastically alter the battlefield of tomorrow. The U.S. Army Training and Doctrine Command (TRADOC) acknowledges the existence of this technology. However, acknowledged existence does not field new technology, and doctrinal apathy toward fielding innovative technology is an issue that may well parallel the stupidity of Spartan refusal to build walls around their cities.

It defies logic that an organization devoted to the evolution of training and doctrine would endure a policy that stymies the advancement of technology. This is not to imply that TRADOC willfully retards technology. Rather, it points out the need for combat developers to think in terms of new technology. As long as combat developers write concepts and operational requirements in response to material developer's technology, fielding of high technology systems will be a protracted struggle. Ultimately what happens is that combat developers continue to address the high technology requirements of AirLand Battle-Future with antiquated methodology. In the long run, this means that the U.S. Army will continue to steadily lose ground to a Soviet threat that pushes to field technology consummate with future oriented "voyennaya doktrina" (military doctrine).

This position will result in our becoming a nation professing to be the bastion of capitalism when in reality we are a "paper tiger". Our adversary, be it in all-out armed conflict or through a third world struggle, is communism. Threat has learned to breed communism in the corruption of capitalism and nurse it on the apathy of the American people. Thus, the danger of communism is not the communist people, it is ourselves and the fanatical few who are in a position to force an entire nation into a policy of communist "manifest destiny."

Very few Americans realize the devotion true communists have to the propagation of their ideology, nor do they realize the time frame communists attach to their work. In the communist mind the state is an entity with a life span far greater than an individuals, so great that it approaches immortality. For disciples of communism it is the continuance of the state that assures one of immortality. With this mind

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CLEAR THE WAY

by MG Daniel R. Schroeder
Commandant, U.S. Army Engineer School

As the title "Clear the Way" suggests, engineers are aggressively preparing to clear the way for the combined arms team in close combat in the 21st century. We've devoted this issue to engineer combat development actions being considered to help the Army fight under the AirLand Battle-Future (ALB-F) concept.

AirLand Battle-Future is a conceptual effort to describe how the Army will fight on the mid- to high-intensity battlefield against modernized opposing forces in the year 2004. This concept is an evolution of AirLand Battle doctrine over the next 15 years. ALB-F is designed to defeat the enemy's main effort at times and places of our choosing, both forward in the division depths and rearward into tactical depths (our brigade rear boundary).

It is essential that we choose projects that will provide the greatest benefit to our future warfighting capabilities. It is not possible to concentrate on all the good ideas available. Therefore, engineer combat development efforts focus on areas that are crucial to the success of ALB-F. Systems used throughout the close fight are the most essential. These systems must be killers and supporters of killers. Tough resource choices for a hard-nosed priority system that must be based on the nature of the fight. Some systems further removed from the forward line of troops (FLOT) will not be top priority.

The Engineer School's Directorate of Combat Developments will determine future engineer needs and resolve deficiencies in current battlefield capabilities. Solutions to these deficiencies will lead to changes in doctrine for the way engineers will fight and support maneuver, changes in training and organizational structure, or the materiel acquisition process for production or improvement of engineer equipment. Many solutions require a combination of these changes.

Our organizational solution, E-Force, is imperative for the successful execution of ALB-F. E-Force fixes present force structure problems and provides increased productivity within programmed resources. The July 1988 issue of ENGINEER featured the E-Force concept and provides the latest update on E-Force actions.

The Engineer School has defined a program of materiel solutions that will give the U.S. Army the ability to aggressively pursue the requirements of ALB-F. These materiel solutions fix engineer equipment problems in the five battlefield mission areas of mobility, countermobility, survivability, sustainment engineering, and topographic engineering. Although we will not neglect survivability and sustainment engineering, we are concentrating our efforts on the other three areas.

We must improve battlefield mobility before we can implement ALB-F concepts. We need to move faster, strike harder, and finish quicker to win battles in the next war. As Confederate General Nathan Bedford Forrest noted, the key to success in battle is to "Get thar fustest with the mostest." This advice is still valid. Engineer support to offensive operations is the key to getting there first with the most. Effective countermine and complex obstacle breaching capabilities are vital to improving friendly mobility.

Mine warfare will change dramatically. Our goal in future mine warfare is to counter the enemy's mobility and degrade their forces without human intervention. Future minefields will serve as combat multipliers in gaps or where few friendly forces are located. Countermobility efforts will focus on state-of-the-art mine systems that include remotely controlled and "smart" technology.

The importance of wise use of terrain will become increasingly apparent on the future battlefield. Engineers must educate maneuver commanders in understanding how the terrain can help win the battle.

Communications and automation will be critical on any future battlefield. The Engineer School is working with research and development laboratories to develop new technology to create more efficient and effective command, control, communications, and intelligence (C3I) systems.

Computerized combat models are essential for analyzing warfighting. While our modeling efforts help the rest of the Army understand the importance of engineers on the battlefield, we must improve those models to better represent engineer forces and combat systems on the battlefield.

We are advancing in our study of space—the final frontier—and its military applications. Engineers are developing requirements for a space station and are involved with experiments that evaluate the use of man in space-supporting combat operations.

Serving as the focus for engineer conceptual, developmental, and evaluational efforts, the Engineer School will continue to ensure that the Corps of Engineers clears the way for the rest of the Army. Our engineer soldiers will be better organized, trained, and equipped to fight and win according to the ALB-F concept.

BRIDGE THE GAP

by CSM Acie R. Gardner
U.S. Army Engineer School

The Engineer School is not moving, it has moved! Fort Leonard Wood officially became the U.S. Army Engineer Center on October 1, 1988.

Camp Humphreys, later renamed Fort Belvoir, was the home of the engineers for almost 70 years. The folks there did an excellent job teaching our officers and noncommissioned officers the necessary war fighting skills.

Now that the school has moved to Fort Leonard Wood, the opportunity for our soldiers to expand those skills is greatly increased. We can increase the hands-on, "get out of the classroom and into the field" training that best provides realism.

We also have an opportunity to integrate training. In housing all aspects of training, we combine one station unit training (OSUT) and advanced individual training (AIT) with the basic and advanced noncommissioned officer courses (BNCOC and ANCOC) and the engineer basic and advanced officer courses (EOBC and EOAC).

A primary goal is to train engineers from the initial entry training to the engineer officer advanced course. Privates will learn their jobs firsthand and develop their first relationship with the noncommissioned officers responsible for training and leading them. Officers and senior sergeants will experience hands-on field training and opportunities to practice the principles of leadership as their training is combined with that of fellow engineers. We are limited only by resources, but with initiative and creativity, I believe we will overcome the lack of resources to make the training realistic and effective.

I encourage anyone who receives soldiers from Fort Leonard Wood to provide us feedback regarding their training. Do soldiers trained at Fort Leonard Wood arrive in your unit with the knowledge required to do the job in their MOS, or must you spend time getting them up to speed? Are our soldiers the best that they can be? Your feedback will tell us if we are training soldiers correctly.

If the feedback is positive, fine. We will keep going. But, if you tell us that the training soldiers receive here—whether it is an MOS-producing course or an NCO basic or advanced course—isn't preparing them adequately, we will stop, look at what we're doing, and ask ourselves some hard questions about the program of instruction and our training philosophy.

This leads to my next point—how our junior soldiers will be selected for BNCOC under the Personnel Command's (PERSCOM) new system, BNCOC Automated Report System (BARS). We must be well versed in these procedures because we now play a major part in who attends and who does not.

A major change under BARS is the attendance priority for BNCOC. The priority for an E6 is by date of rank (DOR); for an E5 on the E6 promotion list, priority is by promotion points; an E5 is by DOR; and an E4 on the E5 list is by promotion points.

Beginning on October 1, 1990, promotion consideration to sergeant first class requires successful completion of BNCOC. So, if you are an E6 hoping to put on that next stripe, you know that you must attend BNCOC.

The BARS system works this way: A list of eligible soldiers, based on attendance priorities, is provided to the PERSCOM, who screens the list and releases it to all installations. The posts are responsible for breaking the list down to the unit level. The report is forwarded through channels to the unit first sergeant, who is responsible for deletions, corrections, and other changes concerning the individuals scheduled for schooling.

The BARS report has three categories. Part I, Reservations Roster, lists soldiers nominated for school, course dates, and course numbers. Part II, Candidate (Substitution) Roster, lists soldiers who meet the qualifications to attend BNCOC but are not considered the best qualified to fill the limited quotas. Part III, Exclusion Roster, lists the solders who are ineligible to attend BNCOC and the reasons why.

Selections for BNCOC attendance are made Army-wide. However, if a soldier cannot attend a course, the installation or activity selects a substitute from the solders listed in Part II to fill the vacancy. With the emphasis placed on schooling and the shortage of school quotas, we must make sure that every available quota is filled with the most qualified soldier.

Unit first sergeants must closely monitor the BARS report. If there are errors or an individual's status changes, the unit first sergeant must take the steps needed to correct the report.

Do not keep a soldier from attending a course to accomplish a short-term mission. In the long run, that soldier won't be there because he or she missed the schooling necessary for promotion. We owe it to our soldiers, and to ourselves, to give them every opportunity for military schooling and to be successful.

Essayons!

Engineer Update

—SCHOOL NEWS—

Directorate of Training and Doctrine (DOTD)

Knowledge is no good unless you share it and employ it! We are here to serve your needs. The Director, COL John H. Thomson, can be reached at (314) 368-1174 or AV 581-1174.

Precommand Course (PCC). The engineer phase of the PCC is now conducted at Fort Leonard Wood. The POI has been revised to include the latest doctrine. For more information, call the Staff and Faculty Division at (314) 368-5261 or AV 581-5261.

Reserve Configured Courses (RC3) for Engineers. All RC3 course work is now conducted at Fort Leonard Wood. USARF schools and ARNG military academies still contact Fort Eustis, VA, ATTN: ATIC-ETS-DS, for materials. Direct questions and comments on the course materials to USAES, ATTN: ATSE-TDR-T, Fort Leonard Wood, MO 65473-6650. The POC at the Reserve Training Office is LTC Doll or Mr. Kovalcik. Call (314) 368-4263, or AV 581-4263/1174.

DOTD Staff. We now have about 50 percent of the DOTD at Fort Leonard Wood and 50 percent at Fort Belvoir. By August 1989, we expect about 80 percent of the staff will be at the new Engineer School in Missouri.

Sverdrup Gate

Front Gate Dedication. With the stroke of a pen, the U.S. Army Training Center, Engineer is no more. It hasn't disappeared off the face of the earth exactly. The post just changed its name to the U.S. Army Engineer Center and Fort Leonard Wood.

Ceremonies, including the dedication of the front gate to MG Leif Sverdrup of St. Louis, marked the occasion on October 1, 1988. The transformation highlighted additional milestones for the post, which became the regimental home of the Engineer Corps and the Engineer School on June 1, 1988.

"Since the formation of the Corps of Engineers and formal military engineer instruction, the objective has been the consolidation of all engineer training at one location," MG Daniel Schroeder, Post Commanding General, said during the ceremony.

COL Thomas Reth, Director of Engineering and Housing, opened the gate dedication ceremony. "Today we continue our efforts to link yesterday's heroes and today's soldiers. It's important that we do so because, without traditions, the rich heritage of the Corps of Engineers could not be passed down to future generations," he said.

MG John G. Waggener (USA retired), former Post Commander, said "Today is the start of the revitalization of our combat engineers." He recalled the engineer heritage from the Revolutionary War to Grenada. "History alerts us, it alerts you, the combat engineers. Be ready!" he warned.

SGT Ronald Hake, Drill Sergeant of the Year, unveiled the post's new designation, U.S. Army Fort Leonard Wood, "The Engineer Center."

Molly Sverdrup, MG Sverdrup's widow, said her husband was three things: an engineer, a citizen, and a family man. She recalled that one of her husband's most cherished moments was when GEN Douglas MacArthur, in awarding him the Distinguished Service Cross, described Sverdrup as "the engineer soldier at his best."

MG Schroeder and Mrs. Sverdrup together unveiled the plaque memorializing Sverdrup and Sverdrup Gate.

Engineer Update

–SCHOOL NEWS–

Directorate of Combat Developments (DCD)

DCD Moves to Fort Leonard Wood. DCD has transitioned from Fort Belvoir to Fort Leonard Wood. The entire directorate is relocated and fully operational. Until the move into the new Loge Hall in 1990, DCD will occupy nine renovated World War II buildings.

Due to extensive planning and coordination, the move was accomplished without adversely affecting the DCD mission. Out of approximately 150 employees, only 34 civilians (including 15 trainees who were hired at Fort Leonard Wood and went to Fort Belvoir for training) and 21 military moved with their positions. The remaining positions were filled by new civilian hires and military newly assigned to DCD. Many changes and adjustments are being made to accomplish the required tasks involved in the transition. DCD remains intact and continues to charge ahead with its mission.

E-Force Concept to be Validated. E-Force is the U.S. Army Engineer School's concept to restructure combat engineer support to AirLand Battle at the division and corps levels. This concept was described in the July 1988 ENGINEER Professional Bulletin reprint of the 1986 E-Force article by MG Kem.

TRADOC has directed that the E-Force concept be validated. An E-Force Independent Evaluation Plan (IEP) has been developed and is being staffed worldwide by the TRADOC Independent Evaluation Directorate (TIED). Once approved, the IEP will be used to develop test documents leading to a field test of E-Force. Both combat engineer and supporting logistical units will be reorganized and tested. The tests will determine the warfighting capability, operational flexibility, and logistic supportability of the concept. In addition, the E-Force concept will be computer modeled by the TRADOC Analysis Command (TRAC). Results of both field testing and modeling will be used to gain concept approval from the Army Chief of Staff.

E-Force implementation will only affect engineer support to the close combat heavy force. The Directorate of Combat Developments and the Engineer Personnel Proponency Office at Fort Leonard Wood are studying the potential impacts of this implementation on the total force in terms of unit conversions, unit stationing, and personnel distribution by specialty and grade. These impacts will be discussed during the 1989 Engineer Commanders' Conference at Fort Leonard Wood, MO.

For more information on E-Force, contact Mr. Vernon Lowrey or CPT Joseph Seerley, (314) 368-1366 or AV 581-1366.

Directorate of Engineer Branch Safety (DEBS)

Engineer Safety. The Fort Leonard Wood Safety Office has expanded to include engineer safety. Now designated the Directorate of Engineer Branch Safety (DEBS), our mission is to provide current technical information and safety support for engineers Army-wide. A library containing information on safe techniques and success stories is available to everyone.

POC is Tom Moran, ATZT-S, Fort Leonard Wood, MO 65473. Or, call (314) 368-7174 or AV 581-7174.

–REGIMENTAL NEWS–

Regiment Establishes New Home. With the establishment of the Engineer Center at Fort Leonard Wood, the regiment is also establishing itself in its new home. The Regimental Adjutant on board is LTC Archibald Gallup. He can be reached at the Engineer Personnel Proponency Office, (314) 368-2266 or AV 581-2266. The school historian, Dr. Larry Roberts, is assisting with unit histories.

The regiment will soon have a regimental affiliation certificate for all present members of the Corps. This certificate will be presented to all advanced individual training (AIT) graduates and newly commissioned engineer officers. With the certificate and crest, new engineers will receive a colored rendition and a short history of the engineer crest. Both the certificate and rendition will be suitable for framing.

We hope to have a replica of the first in a series of regimental paintings at Fort Leonard Wood's Regimental Dinner in May. The painting depicts Gouverneur Warren, Chief of Engineers of the Army of the Potomac, at Little Round Top during the Battle of Gettysburg. Advance orders of the painting, commissioned from Dale Gallon, can be placed at the dinner. A limited number of prints will be available to Regimental Association members.

The Engineer Regimental Association Is establishing itself as a nonprofit corporation within the State of Missouri. The purposes of the association are to promote Army engineering; disseminate knowledge of military art and sciences, with special attention to the role of Army engineering; promote the professional development of its members; and foster and preserve the spirit, traditions, and solidarity of the engineers.

Ordnance Corps Certificate of Affiliation. The Ordnance Corps Certificate of Affiliation is ready for distribution to all ordnance soldiers. To be eligible, a soldier must hold an Ordnance MOS or area of concentration. All Ordnance commissioned officers, warrant officers, and enlisted personnel are also eligible to receive a certificate.

Beginning the 1st quarter of FY89, certificates will be issued by schools awarding the MOS or AOC. Therefore, units need only request the number of certificates for soldiers currently in their units.

Requests for the certificates should be consolidated at battalion level or higher and forwarded to: Office, Chief of Ordnance, ATTN: ATSL-O-S, Aberdeen Proving Ground, MD 21005-5201.

Include the following information in the request: name of unit, UIC, military address, POC, telephone number, and number of certificates required.

MOS 00B (Diver) Standards of Grade Authorization Change. The Office of the Deputy Chief of Staff for Personnel has approved a recommended change to the Standards of Grade Authorization (SGA) table for MOS 00B (Diver). This change retains senior enlisted diving expertise by providing Army divers a career progression to Master Sergeant (MOS 00B50). Five positions at the E8 level have been created. Procedures are being developed to select highly qualified soldiers in MOS 51Z, who previously held the diving MOS, to fill these key diving positions. Improvements in diving safety, personnel management, validation of qualified personnel, and retention of technical expertise are expected in the diving community as a result of this change. The revised SGA table will appear in the October 1989 update of AR 611-201.

Point of contact is SFC Eelman, Engineer Personnel Proponency Office, United States Army Engineer School. Call (314) 368-2266 or AV 581-2266, or write, ATTN: ATSE-EP, Fort Leonard Wood, MO 65473.

Combat Engineers for AirLand Battle Future-Heavy

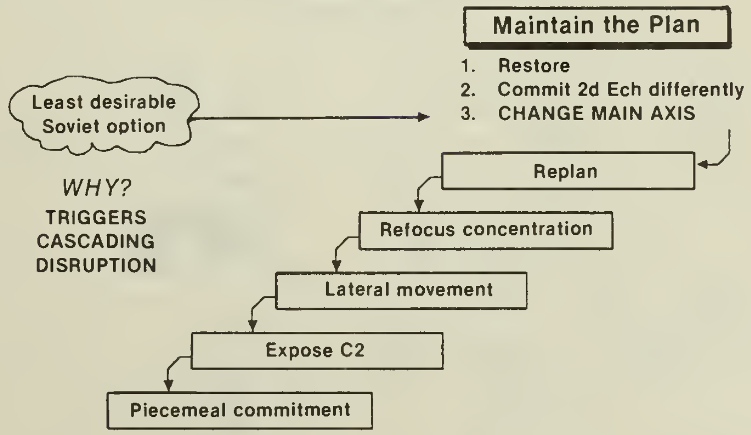
by CPT Robert Hanson and Mr. Vernon Lowrey

The U.S. Army changed its warfighting doctrine to "AirLand Battle" in 1982. This doctrine, as revised in the 1984 edition of FM 100-5, *AirLand Battle*, guides our operations today and for the near future. But, is it capable of success in the future? How will we fight at the turn of the century, and what threat we will face in 2004? What will the focus and contribution of combat engineers be in 2004?

Expected changes in the threat, evolution of AirLand Battle doctrine, and requirements of combat engineers to support the doctrine are described briefly here. They were developed by the AirLand Battle-Future Special Study Group, at Fort Leavenworth, Kansas. Quotations in this article are from their draft operational concept, "AirLand Battle Future-Heavy 2004," dated January 10, 1989.

The future battlefield will be extended in time and space. It will be fluid and nonlinear, lethal, and intense. Through the year 2004, Soviet doctrine will continue to rely on tempo, mass, echelonment, deep operations, maneuver, and flexibility. Increased responsiveness in fire support acquisition and targeting will be coupled with their already formidable indirect fire capabilities. The percentages of motorized infantry and aviation will increase relative to the percentage of tanks in the ground force structure. Armor formations will remain the operational arm of decision. First generation, directed energy weapons will attack electronic sensors and human faculties such as vision. Specialized helicopters for ground attack and air attack will complement the combined arms force structure. Perhaps the most significant development will be a practicable, automated troop control system.

The primary task of Soviet regimental through front commanders will be to maintain their operational plan. Thus, United States warfighting doctrine must reduce the tempo of Soviet operations, causing them to abandon their plan. If the Soviets cannot restore the plan or commit their second echelon differently, they must change the main axis of attack, as shown in the illustration.



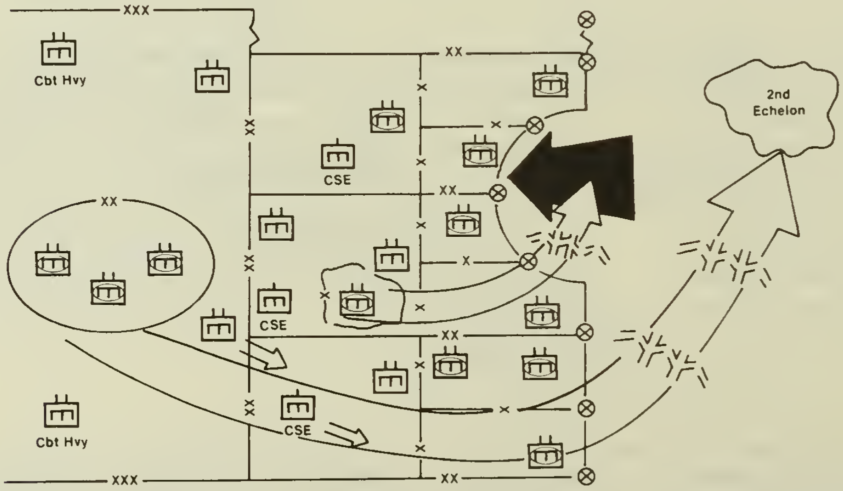
To meet the projected threat, the special study group developed the concept "AirLand Battle Future-Heavy 2004" for warfighting in the year 2004. The concept for this doctrine evolves from current AirLand Battle doctrine. The four basic tenets of AirLand Battle—agility, initiative, synchronization, and depth—are joined by a fifth tenet, endurance. "Endurance is the ability of a force to sustain high levels of combat potential relative to its opponent over the duration of an operational campaign—its staying power."

The concept focuses on the U.S. heavy corps as the operational instrument. It expands the depth of close operations to extend from the rear of the friendly divisions to the rear of the enemy divisions in contact. The concept requires the "near simultaneous decisive engagement of enemy divisions committed and uncommitted echelons or reserve forces...the objective of such operations is to seize the initiative with tactics that destroy Soviet divisions and regiments in hours and minutes."

Future combat engineers will support operations throughout the depth of the battlefield. Mobility operations will be conducted in stride and under fire, breaching both threat complex and naturally occurring obstacles. Engineer units will be fully integrated into maneuver formations, well forward, and provide reconnaissance support and responsive breach capabilities. Countermobility will provide the ability to disrupt the tempo of threat operations and create opportunities for mass destruction of threat formations. Dynamic and multidimensional obstacle emplacement will be executed when and where required. Survivability operations will enhance the endurance of the force by rapidly preparing fighting and protective positions. Engineers will complement inherent vehicle protection and concealment. Topographic engineering products will be used in operational and tactical planning and will assist in precise targeting for weapons systems. Sustainment engineering will provide the endurance of the force. The engineer effort will focus on maintaining lines of communications (LOC) into the division and brigade areas.

Future engineer organizations will be structured and equipped for operations well forward on the battlefield. Responsiveness and flexibility, the keys to engineer operations, will be designed in engineer units and systems, command and control functions, and the placement of planning staffs at the appropriate echelons.

ENGINEER BATTLEFIELD LAYOUT
E-FORCE



Training. First and foremost, collective engineer training must be integrated into combined arms training at all levels. Engineer systems will provide imbedded training for crews and operators. Training devices will be used to teach arming and disarming of U.S. mines. Mine effect simulators will be used to train combined arms obstacle breaching (conventional and scatterable). Major training areas will have area obstacle simulation devices compatible with weapons effects simulators such as MILES. Soldiers will receive tough, rigorous training that taxes their skills and endurance (physical and mental). Live munitions will be used in training to reduce anxiety and increase proficiency.

Force Design. Engineers in the division area will support the doctrine with responsive and flexible units. They will be organized and equipped with the right mixes of sappers and mobility, countermobility, and survivability systems. The force structure designed in the E-Force concept fills this requirement. As shown in the illustration, the structure ensures responsive support with organizations echeloned forward, planning staffs down to maneuver brigade level, and the means to execute engineer functions at the point of attack with minimal task reorganization. Augmentation from the Corps engineer structure will provide flexibility to operations.

Materiel. Standoff systems for detecting and breaching threat complex obstacles will be used with rapidly emplaced gap crossers. They will allow maneuver forces to pass obstacles in stride. The ability to deliver scatterable mines throughout the depth of the battlefield will help maneuver commanders disrupt the threat commanders' decision cycles. Land mines will have high lethality, programmable arm and disarm and engagement settings, remote and multiple sensor packages, and several delivery systems. Technological improvements in demolitions will increase their explosive efficiency. Mine and explosives packaging configurations and materials will reduce the logistics burden of the force. Engineer systems, mounted on standard platforms, will be common with the force they support.

The AirLand Battle-Future concept will guide the development of the combined arms approach to warfighting through 2004. The engineer contribution, integrated training, force design, and materiel improvements, will be critical throughout the depth of the battlefield and to the success of the doctrine.

CPT Robert Hanson is the Chief of the Concepts Branch, Directorate of Combat Developments, at the U.S. Army Engineer School. Previous assignments include company commander and S3 in the 20th Engineer Battalion at Fort Campbell, and S4 in the 10th Engineer Battalion, 3d Infantry Division (Mechanical).

Mr. Vernon Lowrey is the primary action officer for E-Force at the U.S. Army Engineer School. Mr. Lowrey is a reserve major assigned to the Headquarters, 35th Engineer Brigade, Missouri National Guard.

Future Land-Mine Warfare

To keep forces at a functional density and still cover a reasonable front, the friendly battlefield commander may deploy smart minefields along key terrain features.

by Dr. Robert A. Sickler

During World War I, land mines became the single greatest threat to armored vehicle deployment, and throughout the history of modern warfare land mines continued to play a major role in degrading mobility. Time, however, brings change. The land-mine obstacle, as used in defensive operations on past battlefields, does not meet the challenges of AirLand Battle-Future (ALB-F). In the future scenario, we are faced with an adversary who will mount a very large force; one that is trained to rapidly and aggressively push into the depth of our operational rear. To maximize the effectiveness of mine warfare in the ALB-F environment, minefields must be highly lethal to threat forces but completely passive to friendly forces. In short, we need "smart" barrier systems.

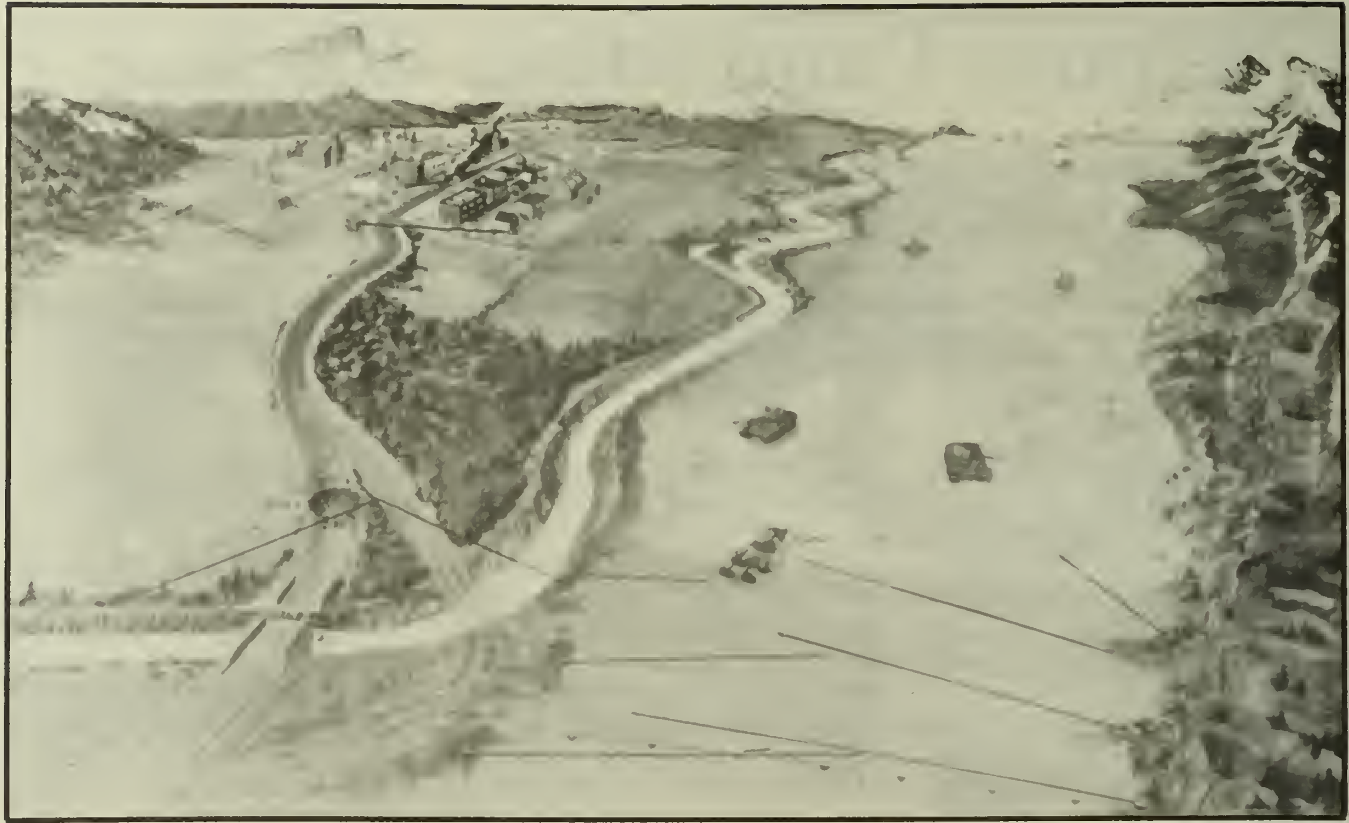
A major objective of future minefields is to counter threat mobility without degrading our mobility. At the same time, smart weapons systems will be employed to destroy threat forces trapped in the minefields. To accomplish this mission without tying up other resources, minefields must possess a standalone capability. In other words, they must function without manned observation/control and without covering fire. With these combined capabilities, the minefields will serve as force multipliers in gaps or lightly manned sectors and disrupt logistics deep in threat operational rears.

In the ALB-F scenario, as initial NATO fronts begin to roll back under the weight of opposing forces, the battlefield will take on a fluid aspect. At this time friendly maneuver commanders must optimize force deployment to meet key threat advances and still remain in tactical deployment. As a result, commanders will face an ever changing array of weak areas and gaps in the defense structure. To keep forces at a functional density and still cover a reasonable front, the friendly battlefield commander may deploy smart minefields along key terrain features. This will allow manpower and firepower to be concentrated at other parts of the contested area while the minefields are left, at least temporarily, to hold the gaps or weak areas.

The smart minefield will differ from the conventional minefield by functioning as an unmanned flexible barrier. It will possess both terrain obstacles and lethal weapons systems. In the past, a minefield was a fixed barrier or a component of a fixed barrier complex. The enemy's knowledge of the barrier's location was sufficient: no enemy vehicle had to be destroyed to fulfill the mission of the minefield. Thus, there is a paramount difference between conventional and future minefields. The conventional minefield barrier is composed of rigid, geometrically configured blocks of mines, and the future minefield will be a complex series of smart munitions and obstacles woven into the terrain fabric.

The typical future minefield may be configured with two parallel mine belts that are separated by a strip of land containing smart antitank munitions. The belts, composed of conventional mines and improved conventional mines, will be located along terrain features that will enhance their concealment and role as an obstacle. The outer belt, the first to be encountered by the threat, will consist primarily of buried mines. This will help them escape detection during threat reconnaissance. The inner belt may be designed to represent a hasty conventional minefield, or it may be a mine belt similar to the outer belt. The area between the mine belts will be covered by smart mines that can engage vehicles over distances considerably greater than conventional mines. These "wide area munitions" will use terrain features to maximize their effectiveness in targeting vehicles and to reduce the possibility of detection.

The entire minefield will remain in a latent mode, functioning as an integral part of the terrain, during early probing by threat reconnaissance patrols. Thus, the area being probed by the threat will appear to be a weak area or a gap in friendly lines. The threat commander, being locked into a rather rigid set of lower unit level tactics, will try to take advantage of what is perceived as a gap in enemy lines. Through these tactics, part of the defense manned by the friendly human element will be relieved of pressure as the minefield is engaged by the brunt of threat forces.



Mines that cover a wide area offer the advantages of concealment and ambush.

During an actual conflict, it is perceived that the smart minefield will wake up from its latent mode as threat forward security elements or advance guard lead elements enter the outer mine belt. Threat forces will proceed through the central killing zone unimpaired until the lead elements encounter the inner mine belt. Then mines in this belt will be activated. The inner belt will stop forward movement and cause following forces to either pile up in the wide area munitions killing zone or come to a complete stop. As the density of threat vehicles reaches a threshold level or threat vehicles reverse their direction of travel, the outer mine belt will be turned on. This will trap threat vehicles between the two belts, where wide area munitions will systematically engage the threat systems.

The future minefield, as described here, will cause threat forces to expend considerable resources—resources that must be resupplied if the threat is to maintain momentum. Resupply will be a threat weak point that can be exploited by disrupting logistics deep in threat territory. A promising system for this deep operational area mission will be minefields that are remotely delivered and possess a stand-alone capability.

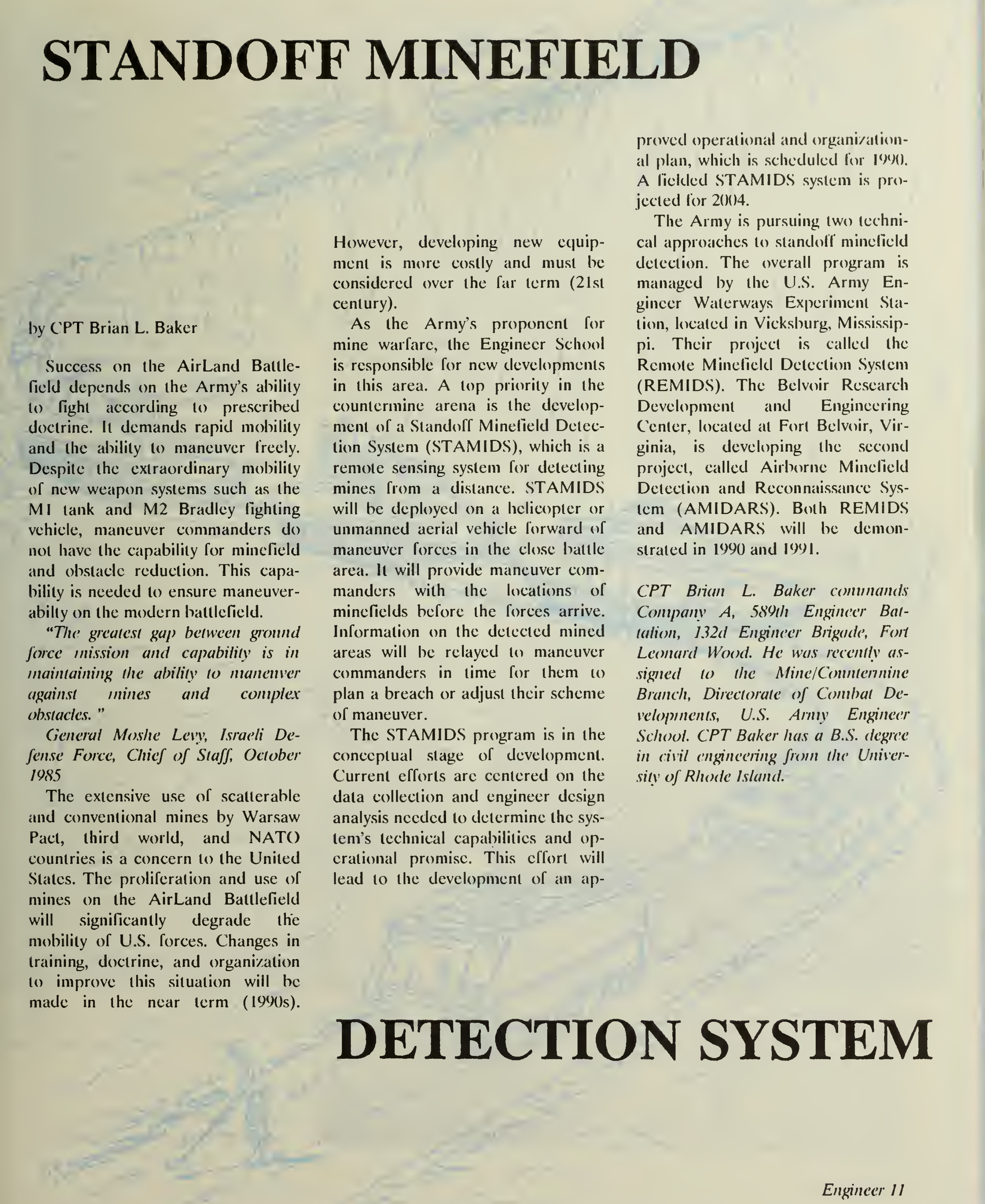
The deep battle area minefields will be tactically located to hamper threat attempts to transition from their initial offensive phase into their subsequent offensive phase. To accomplish this mission, future minefields will be targeted on key features deep in threat territory. Bridges, railheads, crossroads, convoys, and special terrain features are typical targets for the deep battle area mission. Disrupting these resupply routes will make it difficult for threat forces to support both their main axis and supporting axis offensives.

Deep battle area minefields will be considerably smaller than minefields used in close battle areas to hold key terrain. Most of the mines used in a deep battle area minefield will be scatterable, with only enough smart mines to complicate breaching efforts. On targets that are of special interest and where the minefield must contain or hold threat forces for a prolonged time, Special Operations Forces will hand emplace more sophisticated minefields. These minefields will be similar to those used in close battle areas.

Future minefields will enable the battlefield commander to generate unmanned zones that will hold key terrain, reinforce key objectives, or disrupt logistics deep in threat territory. The concepts and capabilities inherent with these needs leap far ahead of conventional systems. Minefields of the future will require highly lethal munitions, sophisticated sensors, and expert system control. Through the judicious use of these technologies, it is conceivable that minefields will be able to operate in the fluid conditions of AirLand Battle-Future.

(biography on page 20)

STANDOFF MINEFIELD DETECTION SYSTEM



by CPT Brian L. Baker

Success on the AirLand Battlefield depends on the Army's ability to fight according to prescribed doctrine. It demands rapid mobility and the ability to maneuver freely. Despite the extraordinary mobility of new weapon systems such as the M1 tank and M2 Bradley fighting vehicle, maneuver commanders do not have the capability for minefield and obstacle reduction. This capability is needed to ensure maneuverabilty on the modern battlefield.

"The greatest gap between ground force mission and capability is in maintaining the ability to maneuver against mines and complex obstacles."

General Moshe Levy, Israeli Defense Force, Chief of Staff, October 1985

The extensive use of scatterable and conventional mines by Warsaw Pact, third world, and NATO countries is a concern to the United States. The proliferation and use of mines on the AirLand Battlefield will significantly degrade the mobility of U.S. forces. Changes in training, doctrine, and organization to improve this situation will be made in the near term (1990s). However, developing new equipment is more costly and must be considered over the far term (21st century).

As the Army's proponent for mine warfare, the Engineer School is responsible for new developments in this area. A top priority in the countermine arena is the development of a Standoff Minefield Detection System (STAMIDS), which is a remote sensing system for detecting mines from a distance. STAMIDS will be deployed on a helicopter or unmanned aerial vehicle forward of maneuver forces in the close battle area. It will provide maneuver commanders with the locations of minefields before the forces arrive. Information on the detected mined areas will be relayed to maneuver commanders in time for them to plan a breach or adjust their scheme of maneuver.

The STAMIDS program is in the conceptual stage of development. Current efforts are centered on the data collection and engineer design analysis needed to determine the system's technical capabilities and operational promise. This effort will lead to the development of an approved operational and organizational plan, which is scheduled for 1990. A fielded STAMIDS system is projected for 2004.

The Army is pursuing two technical approaches to standoff minefield detection. The overall program is managed by the U.S. Army Engineer Waterways Experiment Station, located in Vicksburg, Mississippi. Their project is called the Remote Minefield Detection System (REMIDS). The Belvoir Research Development and Engineering Center, located at Fort Belvoir, Virginia, is developing the second project, called Airborne Minefield Detection and Reconnaissance System (AMIDARS). Both REMIDS and AMIDARS will be demonstrated in 1990 and 1991.

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REMIDS

by CPT Steven R. Dunham and Mr. Richard G. Rhett

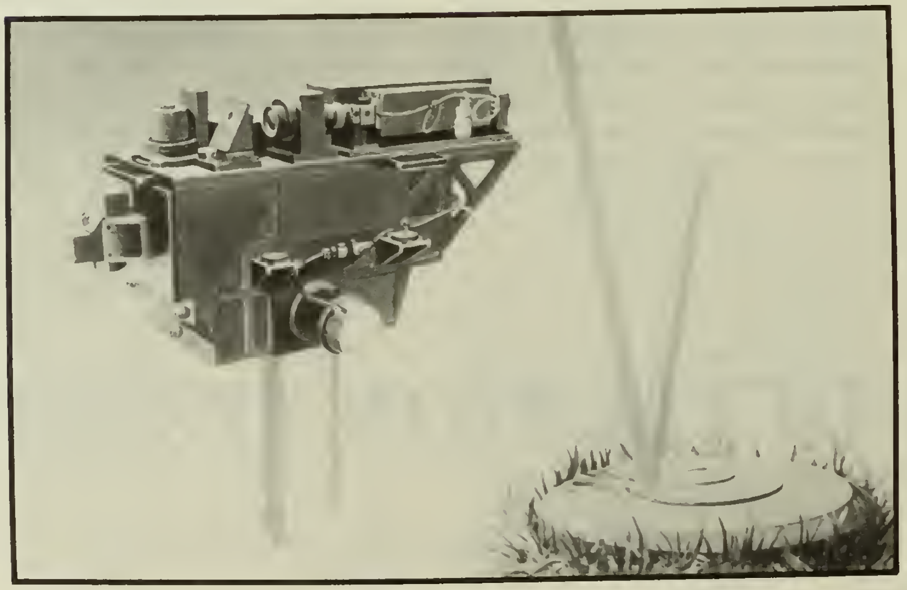
AirLand Battle doctrine's four basic tenets—initiative, agility, depth, and synchronization—are essential to fight and win on the battlefield. On future battlefields, as in the past, obstacles such as mines and minefields will be used by the enemy to impede our ground maneuverability.

The Army's current mine detection capability is very limited. World War II vintage technology still provides for visual recognition and hand-held detectors to locate mines. These methods are slow, tedious, and dangerous. Tank-mounted rollers can often detect and neutralize mines, but they lack the necessary deployment speed and agility to sustain unimpeded maneuverability.

Standoff minefield detection (SMD) will provide maneuver commanders with minefield location data before the ground forces reach the area. This information will give commanders time to plan avenues of advance that avoid the minefields or time to restructure forces to breach lanes through the minefields. The SMD technology is also capable of detecting mines along lines of communication (LOC), main supply routes (MSR), and in other rear area sustainment operations. The Environmental Laboratory at the U.S. Army Engineer Waterways Experiment Station (WES) is developing an SMD system called the Remote Minefield Detection System (REMIDS) to counter the threat to our mobility and sustainment operations.

REMIDS uses specially designed sensors and scanning systems to measure reflective near infrared and emitted thermal infrared information from the ground surface. These bands of electromagnetic energy are outside the visible portion of the energy spectrum. Each object on the ground reflects, absorbs, or radiates in some portion of the electromagnetic spectrum according to its own particular structure, composition, and condition. The frequencies of the reflected energy and the intensity are like a "fingerprint" that can help identify or characterize an object. Man-made objects, such as M-15 mine casings, have characteristic size, surface smoothness, and paint reflectance that influence their reflected and emitted energy.

The REMIDS scanner is capable of both active (laser) and passive (thermal) sensing. The active portion uses a laser power source to illuminate potential targets and the appropriate sensors to measure reflected energy. The passive portion



Laser beam from REMIDS scanner striking mine surface.

of the sensor measures only naturally emitted radiation from the potential targets.

Currently, REMIDS is mounted on a helicopter and can detect surface-laid mines. To locate mines as it is flown over an area, REMIDS records strips of multispectral fingerprints in small units called pixels. The pixels are then reconstructed mathematically as if they were a map. The position data are analyzed through comparison and frequency band ratio techniques to force object characteristics of interest (mines) to stand out.

The REMIDS scanner has been proven during several field tests in desert and agricultural environments. High-speed computer processing is needed to manipulate the data streams recorded by REMIDS. Image processing techniques are applied to process and display data of patterned and scatterable minefields. Future plans call for the processed mine location data to be transmitted by telemetry from the helicopter to the ground for display.

An integrated Army technical demonstration that includes REMIDS is scheduled for fiscal years 1990 and 1991. The REMIDS capability to successfully locate minefields and provide the information to the user in real-time will be demonstrated. In addition, research is planned to downsize REMIDS for use in an unmanned aerial vehicle (UAV) and to expand its detection capabilities to include buried mines. These much needed capabilities will revolutionize the ability of ground forces to perform in accordance with the basic tenets of AirLand Battle doctrine.

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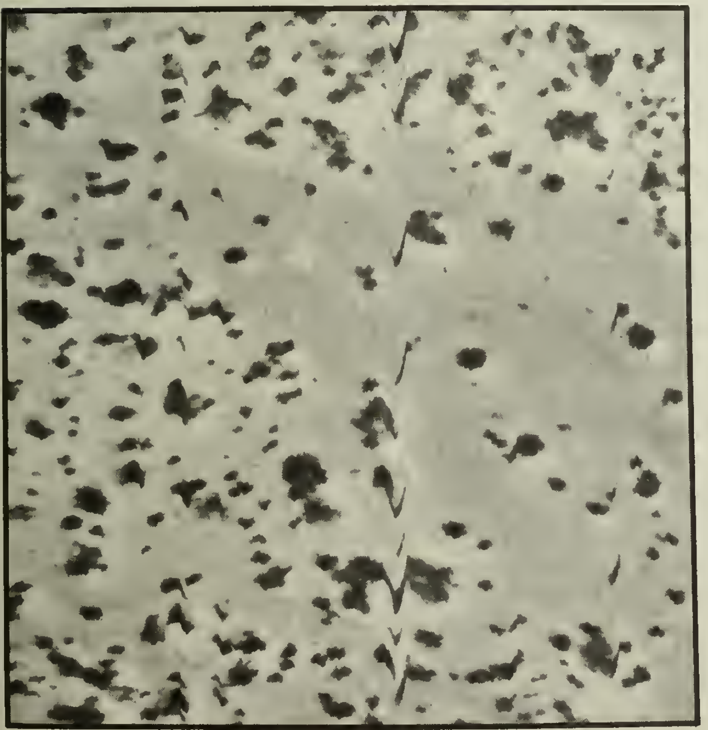
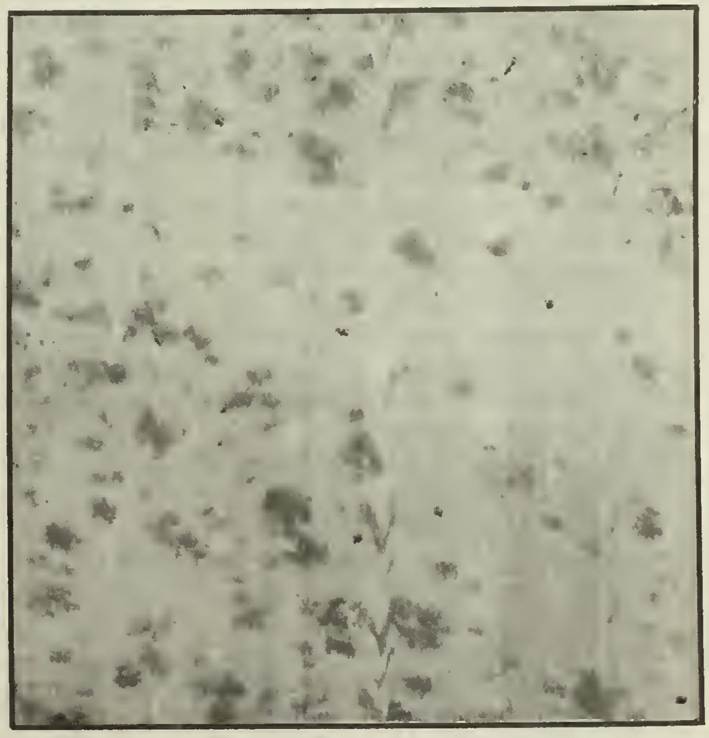
Mr. Richard G. Rhett is a physical scientist currently serving as a research and development coordinator for the Mine/Countermine Program at the United States Army Engineer Waterways Experiment Station, Vicksburg, MS. He has a M.S. degree in biology from Delta State University, Cleveland, MS.



Unprocessed imagery of ground area where surface-laid mines have been placed.



Processed imagery of same ground area that has been analyzed shows the surface-laid mines.

AMIDARS

by Mr. Terilee Hanshaw

Countermine is the key to battlefield mobility. An effective countermine capability is needed to meet the maneuver requirements of AirLand Battle doctrine. But, because the countermine problem is so complex, the U.S. Army has never had an effective countermine capability. To complicate the problem, the threat constantly changes—more countries are producing mines that have increasingly complex sensor and fuzing systems. The bottom line is, there is no easy fix. These general problems are defined by the U.S. Army Engineer School as deficiencies.

Countermine deficiencies are recognized in the 1986 Defense Science Board Report "Mine Warfare" and the General Officer's Steering Committee Countermine Master Plan, as revised in 1988. More recently, the legislative House and Senate reports in their respective National Defense Authorization Acts for fiscal year 1989 expressed concern that not enough priority is placed on countermine technology that will protect U.S. troops and equipment against the strong Soviet mine threat.

The U.S. Army Engineer School identified eight deficiencies in their countermine plan that must be corrected if the United States is to win a war using AirLand Battle doctrine. The top two deficiencies are heavy breaching and standoff minefield detection. Standoff detection of minefields maximizes success in offensive operations and defensive counterattack operations. Striking deep requires standoff detection and breaching systems.

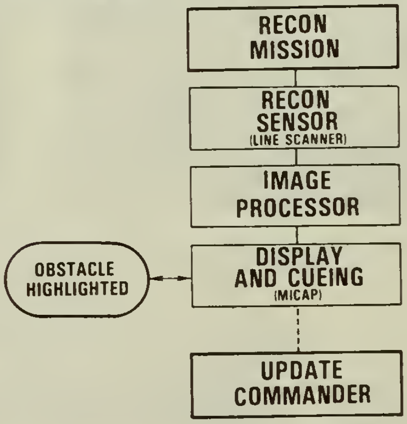
Standoff detection involves the ability to see minefields on the battlefield from a distance and to quickly convey that information to the appropriate maneuver and command elements. Longer standoff detection enables the Army to better organize, synchronize, and use resources to counter the threat. The Airborne Minefield Detection and Reconnaissance System (AMIDARS), being developed by the Belvoir Research Development and Engineering Center (BRDEC), will provide a significant advantage to maneuver forces by maximizing standoff detection of minefield obstacles. The concept of an AMIDARS operation is shown in the chart.

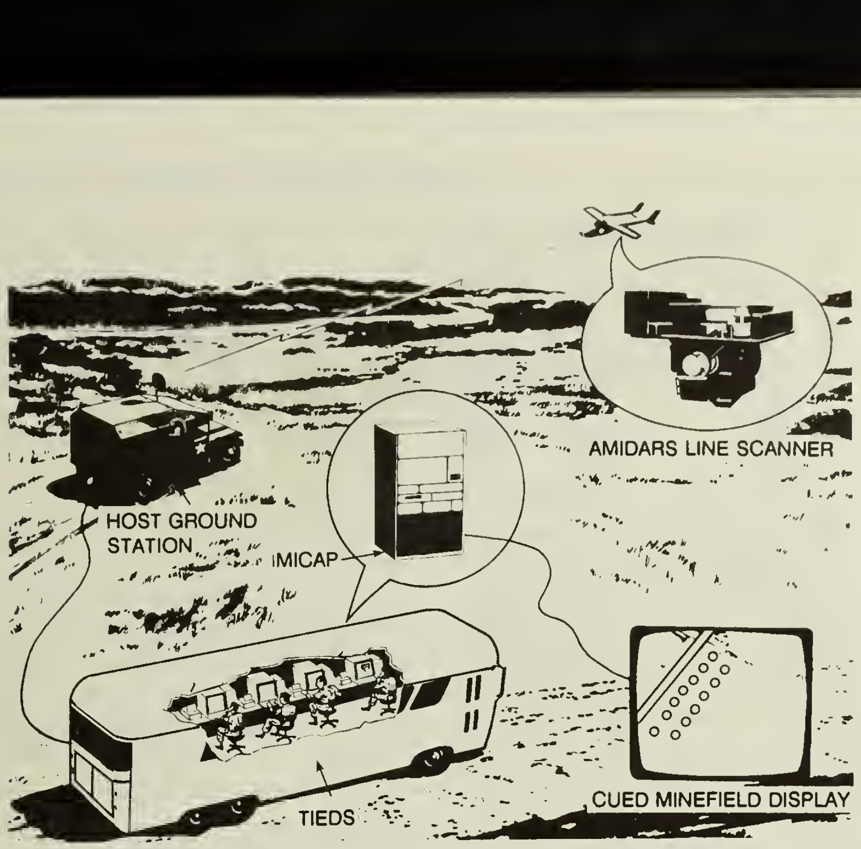
The AMIDARS program is based on more than 10 years of experience and analysis of visual infrared image reconnaissance data for detecting minefields. The AMIDARS technology approach was validated using national reconnaissance assets and commercial infrared line scanners flown on manned fixed-wing aircraft.

The current program thrust is to develop a stabilized, passive infrared line scanner that can fly on unattended air vehicles (UAV). This sensor, when combined with an appropriate data link and ground station, will provide the Army with much needed real-time image intelligence capability. A minefield cueing algorithm and processor is being developed to operate in parallel with a ground station to provide visual cueing. The cueing capability will help image analysts locate minefields. The U.S. Army Engineer School is coordinating the integration of the line scanner data and cueing capability.

A passive thermal infrared line scanning sensor was selected by BRDEC because of its broad potential for detecting targets. Also, its small size promotes use on UAV. The sensor has unique qualities for standoff minefield detection. Passive thermal sensors (in the far infrared spectrum) provide the reconnaissance system with disturbed earth detection. This capability limits the effectiveness of threat visual obscurants and provides little, if any, signature upon which the threat can target.

AIRBORNE MINEFIELD DETECTION AND RECONNAISSANCE SYSTEM (AMIDARS)





The AMIDARS display will be forwarded to maneuver units in time to affect battle outcome.

The ability to detect disturbed earth is important because disturbed earth may indicate buried obstacles or recent vehicular movement. Thus, the ability to detect earth disturbances may be critical to ensure efficient use of valuable engineer resources.

Development responsibility of a prototype AMIDARS passive infrared line scanning sensor is shared under the provisions of a joint agreement between BRDEC and the Center for Night Vision and Electro Optical (CNVEO) laboratories. The sensor is installed on CNVEO's Cessna fixed-wing aircraft for flight testing. A technical demonstration is planned for 1990.

The sensor incorporates several signal processing techniques that enhance thermal infrared images beyond present technology. For example, the AMIDARS design provides a 4 kilometer (km) field of view (swath) when detecting high value targets and a 1 km swath when detecting mine targets. Therefore, the actual area covered in a reconnaissance mission to locate and assess the status of a 10-km forward attack corridor could be 10 km x 4 km. This ensures observation of all targets and potential routes. The sensor signal is digitized and processed on a scan-line-by-scan-line basis. This allows maximum signal content without exceeding system dynamic range. The sensor is stabilized in three axes (roll, pitch, and yaw) with an accuracy that exceeds that of the sensor's resolution. This accuracy supports an optimum image over the entire field of view.

Operating altitudes of the UAV will be determined by environmental conditions (clear skies being optimum) and the ground resolution required for the mission. Most missions will be conducted at altitudes ranging from 1 km to 4 km. High altitudes are preferred to hinder detection by threat forces. Total AMIDARS payload weight is 35 kilograms (kg), volume is 0.04 cubic meter, and power required is 600 watts. Although it is a relatively small package, the AMIDARS line scanner will collect as much data as 30 forward looking infrared scanners (FLIRS) per standard mission.

The AMIDARS system uses multiple microprocessors in a master/slave relationship (a simplified form of parallel processing) to perform video processing, stabilization, formatting, control, and built-in test functions. The system is reliable and allows software modifications. Performance of the sensor is classified but exceeds that of the AAS-24 and the AAD-5 standard Army sensors.

BRDEC has assumed full responsibility for developing the minefield cueing algorithms. The initial stage of the algorithm development is complete. Using divergent approaches, three algorithms were developed that empirically establish the feasibility of automated minefield recognition and cueing. These algorithms use successive stages of programming in which image features such as shape, extent, and statistical properties serve as the basis upon which the presence of a minefield or obstacle is determined.

Minefield cueing refers to the process of converting image data into an intelligence product when targets of interest are identified by the cueing algorithm. Traditionally this conversion is a labor-intensive process that depends on triage and the skills of image interpreters to find targets in the cluttered field of view. Because of the high resolution of the AMIDARS sensor, information is presented to the intelligence analyst for interpretation at a rate that far exceeds human capability for assimilation. If we consider the small size of the mine targets with respect to the total field of view of the system, the magnitude of the search task is so great that it cannot be performed on a real-time basis using traditional analysis procedures. Automatic target feature highlighting (cueing) is a solution to this high rate of data transmission. Cueing is used to help operators process the data quickly by preprocessing the data and pointing out areas of interest. The use of cueing imagery to detect minefields, a key element of AMIDARS development, is called the Minefield Cueing Algorithm and Processor (MICAP).

Direct interface between AMIDARS and the operator occurs through a tactical image exploitation and demonstration system (TIEDS).
(continued on page 32)

Demonstrating SMD Technology

by Mr. Stephen A. Pranger and Mr. Kenneth G. Hall

Future battlefields are expected to be littered with minefields, both friendly and enemy. Troop movement will be countered with obstacles, the fastest and most effective being air- and artillery-delivered scatterable mines. Because of the mobility and firepower of today's armies, the need for a system to detect minefields from a distance is well established. However, detection technology has not kept pace with developments in mine technology, deployment tactics, and doctrine.

Potentially the most dangerous combat situation facing United States forces involves active military conflict with the Soviet forces and/or their major European surrogates. Land-mine warfare has significantly impacted most conflicts in this century, and mine use is expected to increase in effectiveness and frequency in future conflicts. The Soviets possess a highly developed capability to lay conventional mines. They are developing equipment to deliver scatterable mines, similar to those used by the U.S., into all areas of the battlefield. Therefore, a standoff minefield detection (SMD) methodology is critical to counter and defeat the Warsaw Pact (WP) land forces.

The SMD demonstration program managed by the U.S. Army Engineer Waterways Experiment Station (WES) will plan, coordinate, and conduct demonstrations to evaluate the capabilities and limitations of the Remote Minefield Detection System (REMIDS) and the Airborne Minefield Detection and Reconnaissance System (AMIDARS). The standoff detection configurations will be demonstrated in an environment that represents central European terrain and weather conditions. Testing will provide the data required to determine the maturity and readiness of the SMD systems and related technology for their ability to meet performance objectives, readiness for successful follow-on development, operational and economic feasibility, and reliability. The technology demonstrations are designed to produce scientific and engineering data that will show the SMD systems' capability to perform under numerous environmental, atmospheric, and terrain conditions and against several of the most likely threat mines and deployment tactics.

Structured as realistically as practical, the demonstrations will test the systems' performance under various surface conditions, vegetative cover densities and types, land use patterns, and times of the day and night. Representative mines of differing size and case (metal and plastic) combinations and emplacement methods (conventional and scatterable) will be used. Minefield scenarios will reflect the density and distribution of mines used by the WP and NATO offensive and defensive doctrines. A test matrix will be developed to ensure sufficient data are collected under all conditions to establish system performance and the statistical validity of the results.

Demonstrations are scheduled for two 4- to 6-week periods to determine the effects of seasonal changes on the systems. The first will be in September-October 1990, when vegetation is green and leaves are on the trees. The second will be in the winter of 1990-91, when vegetation is dormant.

The minefields will be realistically emplaced according to the U.S. and threat doctrine expected during the reconnaissance of a designed route of advance. U.S. and threat mine systems and surrogate systems will be used for the tests. Minefield locations, minefield rows, and in some cases individual mines will be surveyed for later comparison.

Meteorological and climatological data will be collected by weather stations. Each demonstration will consist of several flights per day, during which sensor imagery will be collected and processed by the SMD systems. The data from each flight will be identified by test number, flight leg, and time tagged for later comparison with associated environmental and atmospheric data. Imagery will be displayed at a ground station, and map products will be generated to show potential minefield sites as referenced to a standard base map.

State-of-the-art concepts for detecting buried mines will demonstrate current technology under different ground conditions such as vegetative cover, soil moisture, and soil density. Because weather affects state-of-the-ground conditions, representative weather conditions will be emphasized.

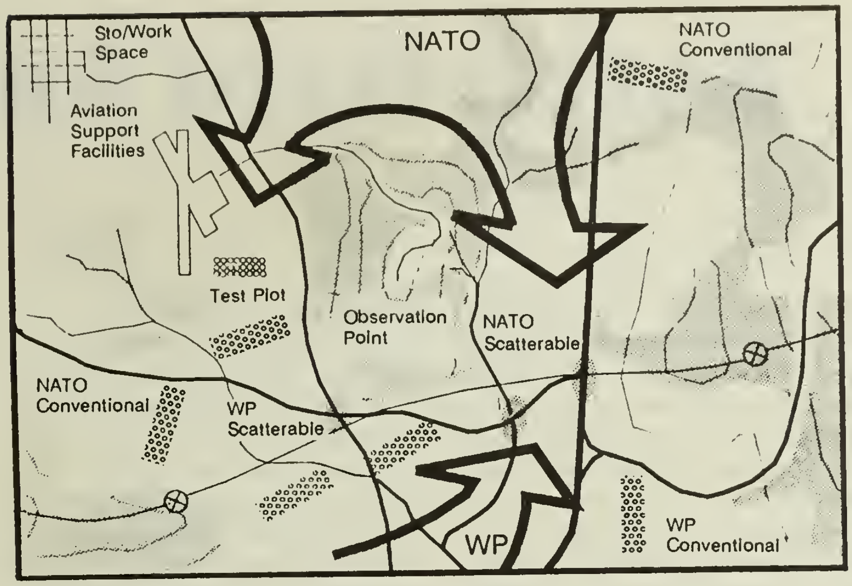
In support of this research, the Environmental Laboratory at WES has established an SMD demonstration team. This team will plan, arrange, and execute the technical demonstrations. Critical tasks include threat analysis, mine acquisition, site selection and coordination, data collection, logistical support, and evaluation of test results.

Demonstration Scenario

The demonstrations will represent current and projected threat scenarios while balancing tactical and operational considerations. Spot reports from units in the field are the tactical commander's most common source of minefield intelligence. However, a detection flight would be useful in an area not previously reconnoitered because of time constraints or counter-intelligence. Prior to the search, the commander will designate the general search area, and terrain analysis will determine likely minefield sites based on the terrain characteristics and threat mine doctrine. Then, military objectives and maneuver tactics will help identify search paths (mission flights). Thus, for each demonstration, specific areas will be mined and flown over to collect useful data.

Test site areas will be identified and individual minefields will be emplaced based on tactical doctrine. For example, mines will not be placed in rivers, in forests, or on the sides of steep slopes. Instead, they will be placed along likely avenues of approach. Troops will emplace the demonstration minefields. Row minefields (not standard pattern) will be used for the conventional mines. Random patterns (computer-generated or operational) will be used for the scatterable mines. Mine locations will be surveyed for ease of recovery and for future assessments of the clearing mission. Minefields will be moved from time to time to ensure a mix of mine types, backgrounds, and climates for the data collection matrix.

Site layout will depend on the specifics of the site. A typical test site layout is shown in the illustration. The objective is to place the minefields in tactically significant positions using the mine placement techniques associated with the minefield type. The test plot will contain several real mines for each type selected, while the minefields will be composed primarily of training mines or surrogates with similar thermal and visual characteristics. The test plot will serve as a reference area and calibration point for each test. The minefields will be placed in as varied an environment as available at the selected site. If necessary, predemonstration preparations will include modifications to improve the appropriateness of the site by mowing grasslands, plowing fields, and planting crops representative of those in central Europe.



Typical site layout for SMD demonstration.

The two types of missions being considered for the SMD systems are the reconnaissance and the administrative clearing. The reconnaissance mission will be used to scout a specific area or route for mines. For an administrative clearing mission, the general location of a minefield is known or suspected. This mission type is used to confirm the location and delineate the extent or boundaries of the minefield for later marking or clearing by engineer units. Start and finish points (way points) will be given to specify the mission paths. Each mission will consist of two to four legs that contain mined and unmined areas. Flights will last from 15 to 45 minutes, depending on the system's data recording capability. Missions will be flown day and night, under different meteorological conditions, and approximately four to six times in a 24-hour period.

The SMD demonstration results will be used to evaluate the current state of the SMD technology. Test results will also be used to assess the direction and shape of future technology developments for a system that can be fielded in the mid-1990s.

Mr. Stephen A. Pranger is a research chemical engineer in the Environmental Laboratory, WES. He is currently assigned to the Standoff Minefield Detection Demonstration Team. He holds B.S. degrees in chemical engineering and mathematics from the University of Connecticut.

Mr. Kenneth G. Hall is a research civil engineer in the Environmental Laboratory, WES. He is currently the team leader for the Standoff Minefield Detection Demonstration. Mr. Hall holds a B.S. degree from the University of Missouri-Rolla.

Battlefield Survival

by Mr. Jeb Stewart

"Curzon walked along the line, with the bullets still cracking round him. 'Get your men digging,' he said to Captain Phelps, the first officer he saw. 'Yes, sir,' said Phelps, 'Er- what are they going to dig with, sir?' Curzon looked Phelps up and down from his cropped fair hair and pop-eyes to his sword belt and his boots. It was a question which might reasonably have been asked on maneuvers. Cavalry had no entrenching tools, and the Twenty-Second Lancers had, from motives of pride, evaded throughout their corporate existence the annual two hours instruction in field fortifications which the regulations prescribed for cavalry. But this was war now. 'Get your men digging, and don't ask fool questions!' The Twenty-Second sank into the earth just as will a mole released upon a lawn. The crudest, shallowest grave and parapet quadrupled a man's chance of life."

The General, C.S. Forester, copyright 1936, Little, Brown & Company, Boston, MA. (Excerpted by permission.)

This fictional but realistic account of the British experience at the First Battle of Ypres, one of the early engagements of the World War I, illustrates battlefield survivability. The reality was that men died because their staffs had not anticipated the deadly effects of the ultimate weapon of the time, the machine gun.

The U.S. Army Engineer School is the proponent for survivability, the doctrinal term for protecting personnel, weapons, and supplies from the observation of and destruction by the enemy. Survivability includes the engineer areas of camouflage and field fortifications. AirLand Battle-Future, the Army's umbrella warfighting concept into the 21st century, anticipates that battles will be short, violent, lethal, and high-tech. We have never done particularly well in predicting the nature of a future conflict. Actually, about all we can guarantee about future battles is the lethality. Technology has guaranteed that if men and equipment can be seen or detected by sensors, they will be killed or destroyed. The sum of all the evolutionary technological advances since World War II is probably analogous to the difference in battlefield lethality between the muzzleloader of the Civil War and the machine gun of World War I. This increased lethality drives the need for survivability.

The Engineer School is developing camouflage doctrine for the Army that incorporates current and projected threat capabilities and intentions through the early 21st century. Each arm and service will develop specific camouflage tactics and techniques that conform to the School's developed basic doctrine.

Camouflage doctrine will be evolutionary, not revolutionary. The major premise will remain: that a soldier or unit that cannot be seen or detected cannot be effectively engaged. However, since AirLand Battle-Future doctrine is maneuver-oriented, we cannot always "hole-up" on the battlefield. The mission requires movement, and movement attracts attention. Therefore, I believe that a mission-oriented, camouflage and concealment (MOCC) concept will help the commander determine the level of camouflage and concealment appropriate to each situation. The need for effective camouflage and concealment extends throughout the depth of the AirLand Battlefield. Because technology has provided us and our potential adversaries with the means to see beyond the forward line of troops (FLOT), no distinction in the application of the camouflage art based on location can be permitted. Combat service and combat service

Digging-in is as Important to survivability on the modern battlefield as it was to these soldiers fighting in the "War to end all wars."

Photographs courtesy of author

support units must practice the same degree of camouflage as combat units. Units that fail to master the highest standards of the art will be detected by threat reconnaissance, surveillance, and target acquisition (RSTA) and will be obliterated by close combat or deep attack systems. Camouflage and concealment will be integrated with the ongoing efforts of other schools who have proponency in such areas as deception, smoke, operational security, and signals security.

Field fortifications include protective and fighting positions. Engineers are responsible for the doctrine, techniques, and equipment that the maneuver commander needs to dig-in the force. Our main potential adversary, the Soviet Union, possesses the world's largest inventory of artillery. The Soviets call their artillery the "god of war," and their tactical doctrine stresses the shock effect of massed artillery fires. Soviet doctrine also considers the effect of "weapons of mass destruction" (chemical and battlefield nuclear weapons) and ties their use to the element of surprise. Thus, if an adversary does not take full protective measures with well dug-in positions, Soviet strategists will consider using nuclear and chemical weapons. We must consider ourselves to have been fairly warned.

Protective positions shield soldiers and equipment from enemy fire. The level of construction effort is based on the intelligence preparation of the battlefield (IPB) and mission, enemy, terrain, troops available, and time (METT-T). On numerous occasions in numerous wars, well constructed protective positions have survived massive artillery barrages and air strikes.

The engineers' challenge is to support the AirLand Battle by designing standard protective positions that can be constructed rapidly, are adaptable to the location, and that make minimal demands on the logistics system for Class IV (construction) materials. The "bombproofs" of our Civil War, the "trench warfare" of World War I, and the "bunkers and firebases" of Vietnam are examples of elaborate protective positions. To execute AirLand Battle-Future, we cannot afford the resources to build similar structures or to lose the mobility associated with those historical precedents. The Engineer School will test some protective positions at the Field Artillery Center's "Soviet" artillery effects test in October 1989.

Fighting positions include foxholes, skirmish trenches, mortar and howitzer pits, tank and infantry fighting vehicle defilate positions, and Curzon's "grave and parapet" that quadrupled a man's chance of life. Soldiers of all arms and services dig and construct fighting positions. Engineers employ digging equipment to quickly and effectively reinforce or augment the occupying unit's efforts. Our major contributions to the Army in regard to fighting positions may evolve from a two-fold effort to design more responsive engineer organizations (E-Force) and to better equip this force. The optimum solution may not be to have more engineer soldiers and units, but to more closely associate our modernized units with maneuver units.

Army engineers are meeting the challenge of survivability on the future battlefield. We are training harder and smarter. We are modernizing our doctrine and organizations, and we are testing the results in field exercises as realistic as we can make them. U.S. Army forces are effective only if the unit, organized with equipment and trained soldiers and designed for a specified purpose, survives the many hazards on the battlefield and completes their mission. Perhaps we will never fight the highest level of combat for which we train. We can hope that the 21st century will be more peaceful than the 20th century has been. But unless the history and course of national conflict change radically, our security will still depend on the ability to survive and prevail on the battlefield. We simply cannot afford the equivalent of Curzon's bitter realization that the staff had not thought about surviving machine gun fire.

Mr. Jeb Stewart, a graduate of Virginia Polytechnic Institute, is a military engineering developments analyst in the Directorate of Combat Development, U.S. Army Engineer School, Fort Leonard Wood, MO.

Personal Viewpoint (continued)

set, the threat of communist expansion is not something that will go away, nor will communists ever be satisfied with anything less than global domination.

It may be true that Russia has no desire to pay the price of conquering the United States. However, only a fool would believe that Russia does not want our international influence removed from its path of conquest.

Wake up, TRADOC! We cannot enjoy the bureaucratic gymnastics of the Roman senate nor the luxury of protracted debate when action is needed. Let us not repeat the terrible mistake of believing every citizen is a stone in the wall. AirLand Battle-Future doctrine calls for state-of-the-art technology. To field new technology, we must first learn to think in terms of this technology, and we must motivate the Army along these lines. If the U.S. Army fails to develop materiel systems that meet the needs of AirLand Battle-Future, we will relinquish the world stage to continued communist expansion.

Dr. Robert A. Sickler is a technical integration analyst with the U.S. Army Engineer School, Directorate of Combat Developments. Dr. Sickler taught in the Mechanical and Aerospace Engineering Department at the University of Missouri-Rolla, where he received a Ph.D.

BRIDGE DEMOLITION

by CAPT Paul Davies

The methods used to demolish simply supported and continuous bridges in this article differ significantly from the techniques explained in FM 5-25, *Explosives and Demolitions*. The methods described here are now taught in the Engineer Officers Basic Course and will be included in the next edition of FM 5-25.

The introduction of new concepts and materials in bridge design, coupled with the need to conserve demolition materials and manpower, has led to new approaches in bridge demolitions. These new approaches will guarantee the success of a demolition. A soldier tasked to demolish a bridge must recognize the characteristics of the target. If the soldier fails to recognize these characteristics, the result of the demolition may be very different than that expected.

The aim of bridge demolition is to destroy certain key parts, making the bridge so unstable that it collapses under its own weight. To do this, a hinge or collapse mechanism must be formed at one or more key parts of the bridge. Once formed, the collapse mechanism must be free to move far enough under its own weight to create the desired obstacle. For example, it may be necessary to cut the end of the bridge, the abutment, or the pier to prevent a collapsing bridge from jamming.

The first step in destroying a bridge is to categorize it correctly. All bridges fit in one of three categories: simply supported, continuous, or miscellaneous. Miscellaneous bridges include suspension and lift bridges. They are destroyed using methods described in FM 5-25, *Explosives and Demolitions*. This article does not apply to miscellaneous bridges.

After a bridge is categorized as simply supported or continuous, it must be further categorized into one of several subgroups. Follow the diagram shown for each main category to completely categorize a simply supported or continuous bridge (figures 1 and 2).

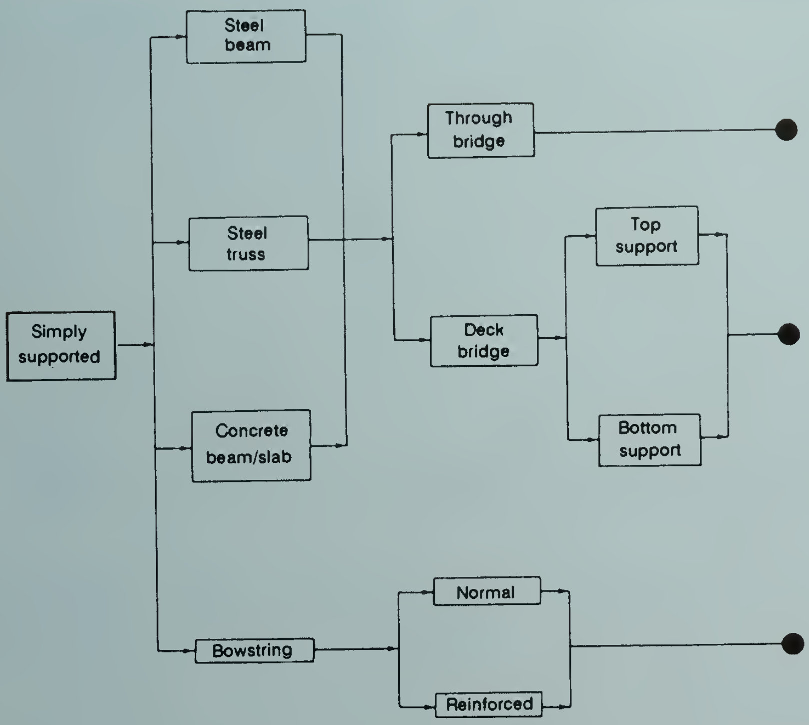


figure 1

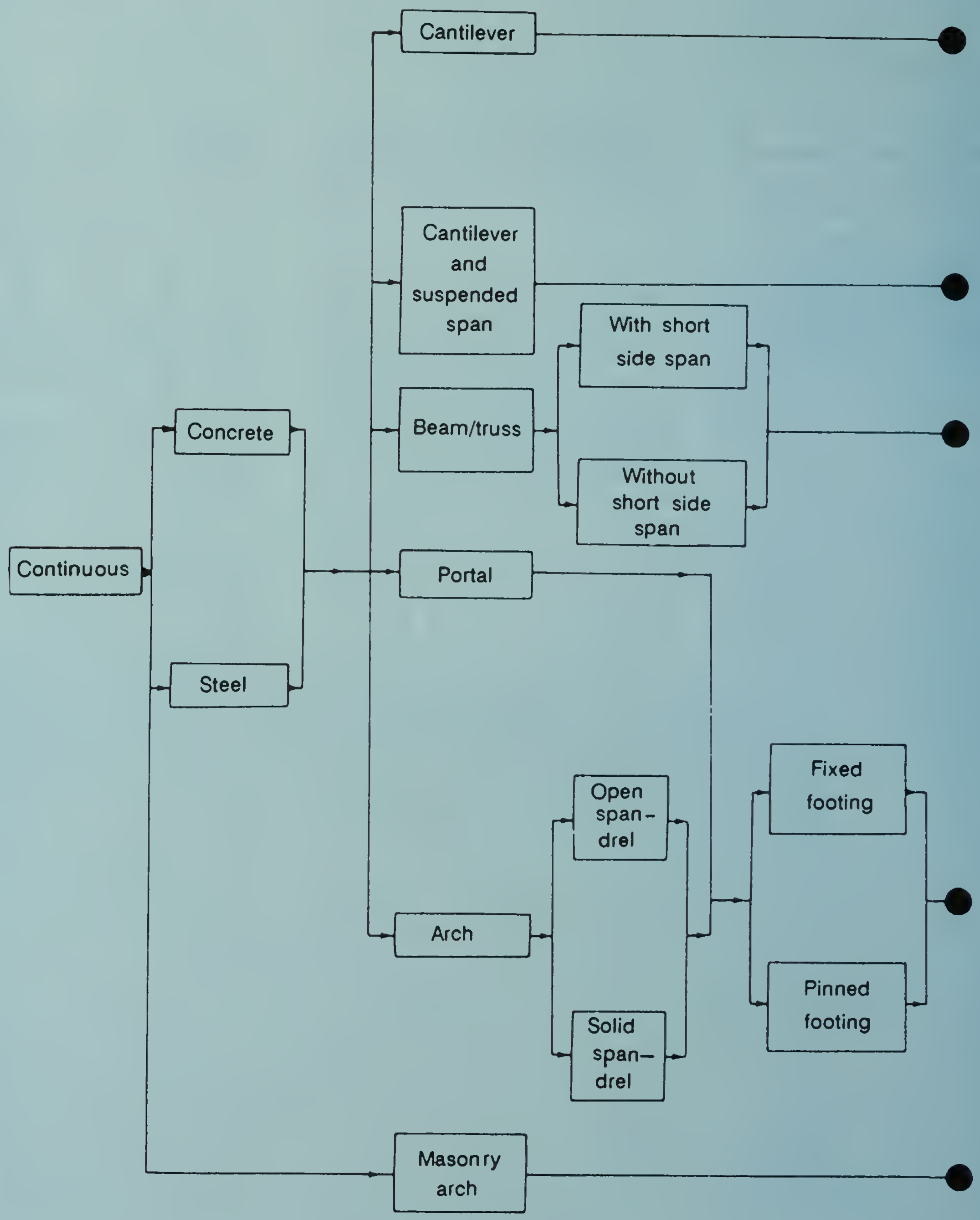
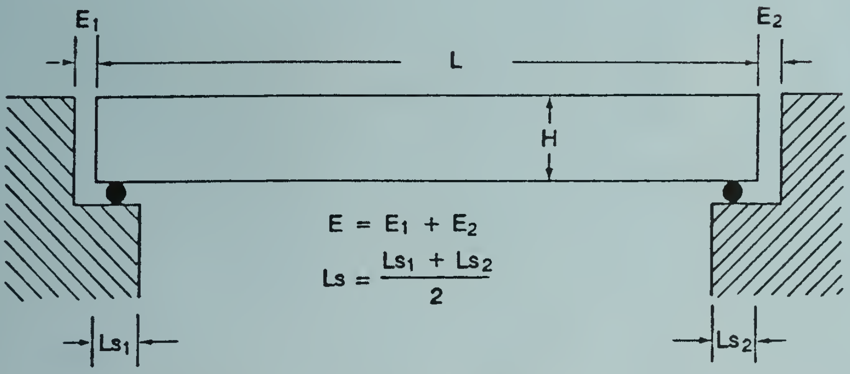

Cantilever
Cantilever and suspended span
With short side span
Concrete
Beam/truss
Without short side span
Continuous
Portal
Steel
Fixed footing
Open span-drel
Arch
Pinned footing
Solid span-drel
Masonry arch

figure 2

Specific measurements are required for each bridge category. The following measurements, in meters, are required for a simply supported bridge (figure 3).

- Length of bridge or span, L. Measure the length of the longitudinal members that support the deck from end to end. This measurement is not the clear gap.
- Beam, truss, or bow depth, H. This dimension includes the deck.
- Total end clearance, E. This is the sum of end clearances at both ends of the bridge.
- The mean of the bearing support lengths, Ls, at each end of the bridge. This is the average of the lengths from the end of the bridge to the face of the pier or abutment.



$$E = E_1 + E_2$$

$$Ls = \frac{Ls_1 + Ls_2}{2}$$

figure 3

Take the following measurements, in meters, for a continuous bridge (figure 4).

- Span, L, for all spans. Measure between the centerlines of the bearings.
- For arch and portal bridges, measure the rise, H, from the springing or bottom of the support leg to the top of the deck or the top of the arch, whichever is greater.

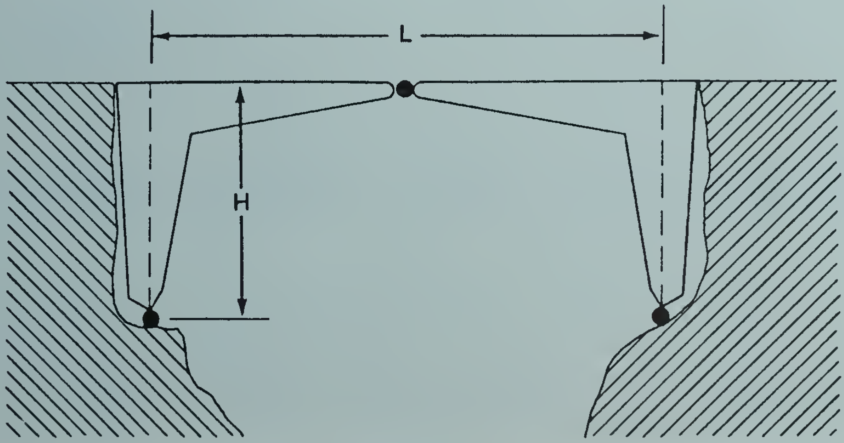


figure 4

The information for all subcategories of continuous and simply supported bridges has been tabulated, as shown in figures 5 and 6. These tabulations show the method of attack that will provide the most efficient demolition. For a bottom attack, compare the measured end clearance with the end clearance required (E_r) for the bridge to collapse without jamming. If the measured end clearance is too small, the end of the bridge, one pier, or an abutment must be attacked to create sufficient clearance. When a top attack is recommended, determine the length of the span (L_c) to be removed from the top of the bridge to prevent jamming.

Example of bottom attack

1. Category. Simply supported, steel beam, deck bridge, with bottom support.

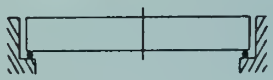
Serial	*Sub-category*	*Type*	*Method of Attack*
(a)	*(b)*	*(c)*	*(d)*
7	Steel Beam	Deck Bridge, Bottom Support, Method I	Bottom Attack: E is greater than E_r  1. Cut at mid-span. 2. Deck need NOT be cut.
8	Steel Beam	Deck Bridge, Bottom Support, Method II	Bottom Attack: E is less than E_r As for Serial 7 and attack the end of the bridge or one pier/abutment to create sufficient end clearance.

figure 5

2. Reconnaissance-initial measurements.

L = 25m
H = 2.1m
E = 0.2m

3. Determine the method of attack. A bottom attack is recommended. Use the following formula to determine if the end clearance required to allow collapse without jamming is available.

$$\frac{E_r}{L} = \left[4\left(\frac{H}{L}\right)^2 + 1\right]^{1/2} - 1$$

$$\frac{E_r}{L} = 0.014$$

Insert the measured value of L to find E_r.

$$E_r = 0.014 \times 25$$
$$E_r = 0.35\text{m}$$

In this example, the measured end clearance is less than the end clearance required. Therefore the end of the bridge, one pier, or an abutment must be attacked.

Example of top attack.

1. Category. Simply supported, normal bowstring bridge.

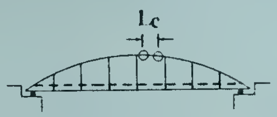
Serial	*Sub-category*	*Type*	*Method of Attack*
(a)	*(b)*	*(c)*	*(d)*
21	Bow-string	Normal	Top Attack  1. Cut at mid-span. 2. Cut bow in two places. 3. Cut all hangers between bow cuts. 4. Deck need NOT be cut.

figure 6

2. Reconnaissance-initial measurements.

$L = 62\text{m}$
$H = 8.5\text{m}$
$L_s = 1.15\text{m}$

3. Determine the method of attack. A top attack is recommended. Use the following formula to determine the length of span (L_c) to be cut.

$$L_c = \frac{2H\left[\frac{L_s}{L} - \left(\frac{L_s}{L}\right)^2\right]^{1/2}}{\frac{1}{2} - \frac{L_s}{L}}$$

$L_c = 4.6$ **meters**

For $L_c = 4.6$ meters, cut the bow 2.3 meters on each side of midspan to prevent jamming during collapse.

Use the following formula to determine L_c for arch and pinned footing portal bridges.

$$\frac{L_c}{L} = 1 - \left[1 - 4\left(\frac{H}{L}\right)^2\right]^{1/2}$$

The point of contact for bridge demolition is the Field Engineering Branch, Department of Military Engineering, U.S. Army Engineer School. For more information, call (703) 664-3411, or AV 354-3411.

CAPT Paul Davies is currently Chief, Field Engineer Branch, Department of Military Engineering, United States Army Engineer School. He is the Canadian Exchange Officer at Fort Belvoir, VA.

LIGHTER, STRONGER BRIDGES

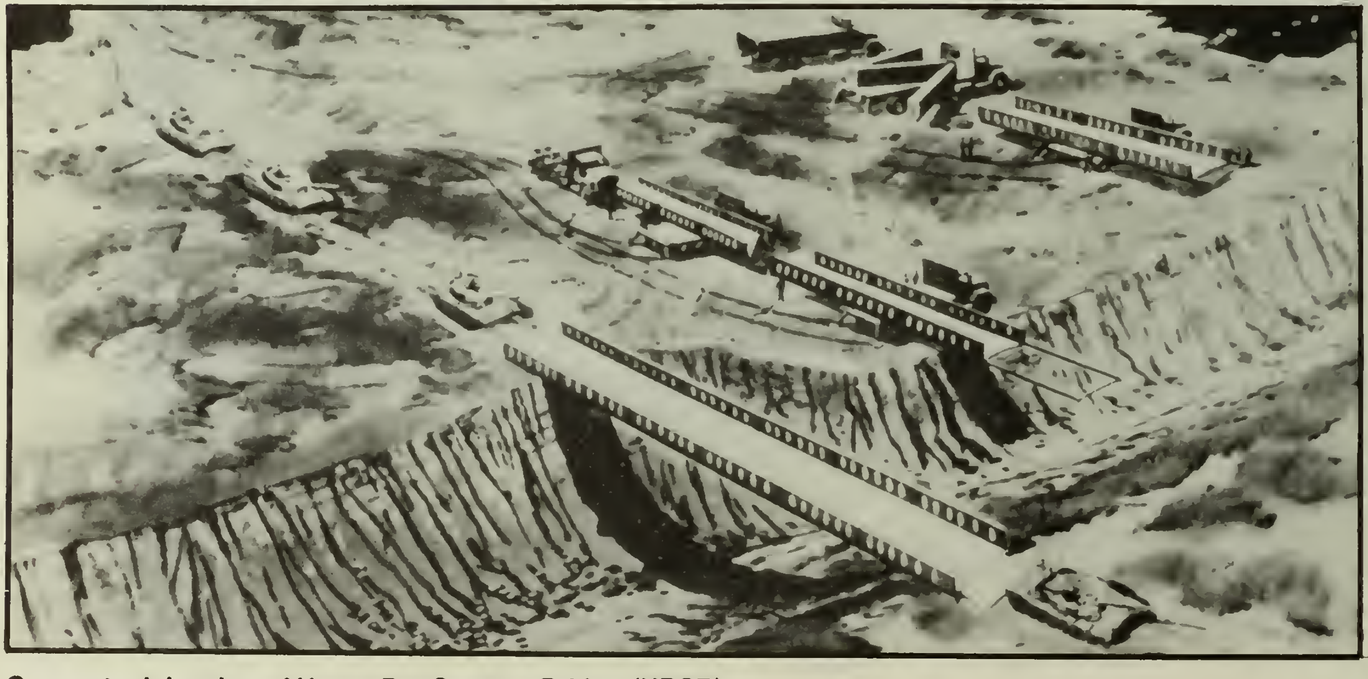
by CPT Carey W. Brown

The research, development, and engineering (RDE) community is now using composite materials to develop U.S. Army bridges. Think of it—a single change of material in the substructure or superstructure can produce a bridge that is 30 percent lighter than a conventional bridge.

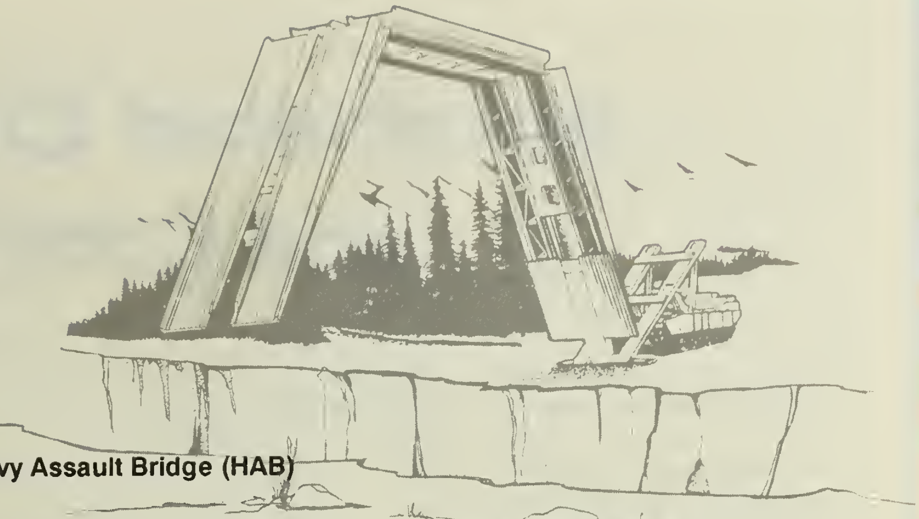
Belvoir Research, Development, and Engineering Center (BRDEC) began investigating this bridging concept in the early 1980s. Research in composite materials, however, began in World War II with the development of fiberglass reinforced plastics for rocket motors. From those early efforts, we now have the potential to field a bridge with composite components in the 1990s.

Composite materials are manufactured by combining a reinforcement material, such as fiberglass, with a supporting binder material, such as resin. A drawback to composites is the higher cost per pound versus such traditional materials as aluminum alloys, but benefits can be obtained through their use. First, composite material has a higher degree of stiffness and strength-to-weight ratio than aluminum alloys. Saving weight in military bridging generates several advantages—the reduced dead load equals more load-carrying capacity, and mass reduction equates to lower transport costs through reduced fuel costs. Second, composites don't rust. By substituting composites for metal alloys, we can reduce or eliminate corrosion and material deterioration to military bridging. This benefit can reduce operational support costs for the entire life cycle of the system.

In the early 1980s, the U.S. Army Mobility Equipment Research and Development Command, Fort Belvoir, VA, (now BRDEC) established a test to compare conventional and composite material bridge components. The test revealed that composite materials were ready for Army application. To obtain



Conceptual drawing of Heavy Dry Support Bridge (HDSB).



Heavy Assault Bridge (HAB)

maximum benefits from their use, the bridge components selected for replacement with composite material should be those that significantly improve the entire bridge system.

Composite materials currently are being used in three U.S. Army developmental bridging programs. The Heavy Assault Bridge (HAB), a replacement for the Armored Vehicle Launched Bridge (AVLB), consists of a tank chassis, launching mechanism, and bridge. A 32-meter bridge being considered for the HAB will have a lower chord made of composite material. A combination of carbon fibers and an epoxy binder material makes up the composite material in the lower chord. A traditional aluminum lower chord would work, but with a military load classification (MLC) 70 at 32 meters, the deflection would exceed one meter, which is not considered acceptable. The high degree of stiffness offered by the composite material reduces the deflection to less than one meter, which is acceptable. The use of composite materials also reduces the total bridge weight.

The Access/Egress Roadway System (AERS), another program that could benefit from composite material, provides an expedient means of improving trafficability at bridge and swim sites. This system consists of a transporter, 25 meters of roadway panels rated at MLC 70, and a launch and retrieval mechanism. By laying the panels over soft, worn, or wet ground, vehicular traffic can continue to use an otherwise unusable road or trail. The composite panels, similar to existing aluminum panels, will be made of a glass fiber and polyphenylsulfide matrix binder. Full-sized panels will be fabricated and tested if development continues on this program. Samples have been fabricated and were tested successfully. Using composite materials for this system reduces the weight in the roadway by about 20 to 30 percent.

The Heavy Dry Support Bridge (HDSB) is a new concept that may replace the Bailey Bridge in the late 1990s. The HDSB may have a tri-arch modular bridge structure carried on a ribbon bridge transporter. Each transporter will carry three 6-meter modules, for a total bridge length of 18 meters. The anticipated load-carrying capability will be MLC 100 at 54 meters.

The HDSB may have several components made of composite materials. The first area being considered is the deck. One alternative is a graphite and polyetherimide section that resembles a landing mat. Another possibility is a foam layer that has outer layers of glass and nylon. The objective of using composites in the deck is to reduce the weight and to achieve twice the stiffness and strength.

A second area being considered for composites is the truss tubes, which are the lower chords of the bridge on the HDSB. The truss tubes are the main load-carrying members of the bridge. The tubes are formed by winding epoxy-coated carbon fibers over a tubular mantel and steel end fitting that connects the bridge sections. The entire assembly is then coated with a wrap of glass and epoxy. The use of composite materials will reduce the weight of the HDSB and provide a bridge that is 54 meters long with a MLC of 100.

The technology for using composite materials in military bridges is not completely developed, but advances suggest that composites will eventually replace some or all metallic bridge components. Advances are evident in the research and development of aircraft components and vehicle body panels. With advances in RDE and improvements in the manufacturing processes, composites can significantly improve the reliability and maintainability of military hardware.

This article acquaints readers with current research and development within the Army bridging program. While not all the systems discussed may be produced, what is discovered may lead us to a family of bridging that is lighter, stronger, and more durable than what is currently in the Army inventory.

CPT Carey W. Brown is the Chief, Mobility Branch, Materiel/Logistics Support Division, Directorate of Combat Developments, U.S. Army Engineer School, Fort Leonard Wood, Missouri.

Automated Command and Control

by CPT Todd Skoog and CPT Vincent Harackiewicz

Scenario: A maneuver brigade changes its obstacle plan in anticipation of a new enemy deployment. Near the forward line of own troops (FLOT), 2LT Liles, a combat engineer platoon leader, receives the mission to emplace several minefields and an antitank ditch as part of an obstacle belt. The platoon must complete this mission in 16 hours. The tired troops are 15 kilometers (km) from the company command post, it is 2200 hours, and fuel is low. It is snowing heavily, and traffic on the main supply route (MSR) in the rear is moving slowly. 2LT Liles quickly surmises that he lacks enough Class IV and V and other logistics support to complete the mission. Thus, the brigade's planned counterattack may be vulnerable to enemy action...

This situation illustrates some of the challenges faced by engineer leaders. At multiple command echelons, the company commander, brigade engineer, and battalion commander will take action to ensure the success of 2LT Liles' mission. Their effectiveness on the complex battlefield depends, in part, on the capabilities of the communications and data processing systems available for their use.

Commanders, assisted by staffs, acquire information, assess whether new actions are required, determine what those actions should be, and direct their subordinates accordingly. In the past, the range of a commander's tactical control was limited by how far a voice could carry, a bugle heard, or a flag seen. The telegraph and the FM radio greatly extended this distance.

Advancing technology also increased the quantity of information available. The computer now expands man's ability to process and evaluate information. As the amount of data increases, the need for standard cataloging or formatting also increases. The U.S. Army's automated command and control system for the 21st century is already planned.

The Army Tactical Command and Control System (ATCCS) meets the operational demands of AirLand Battle doctrine. Five battlefield functional areas (BFA) exist within ATCCS: maneuver control, fire support, air defense, combat service support, and intelligence and electronic warfare. Information flows continuously among and within the BFAs. Each has an associated functional control system that includes personnel, procedures, and material systems. These systems are used to—

- develop decisions concerning the employment and sustainment of combat power appropriate to that BFA
- direct subordinate and supporting units
- coordinate with the other BFA subsystems

The Army is procuring automation hardware and software to enhance the abilities of these control systems. The following equipment is destined for engineer forces in the 1990s.

The handheld terminal unit (HTU), shown in the illustration, formats and transmits digital data using standard Army communications equipment such as SINCGARS. Messages are received and transmitted in fixed, free text, or graphic formats. Because it is IBM PC/AT compatible, the HTU can handle more than just communications tasks. It uses combat engineer application software and commercially available software.

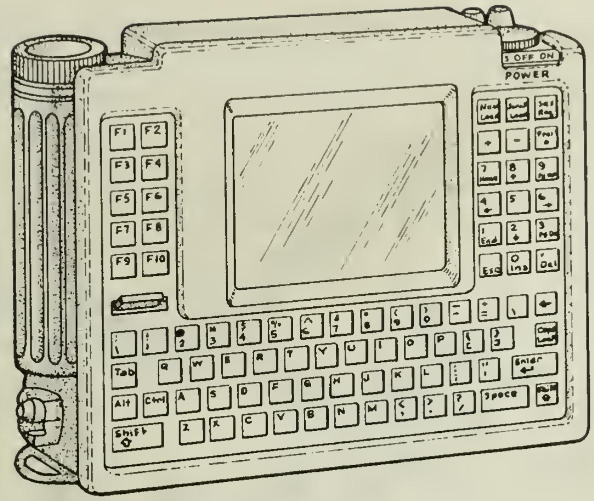
The terminal has an interactive liquid crystal display, an 84-key keyboard, and is battery or vehicular powered. The HTU weighs about 5 1/4 pounds.

The HTU will be issued 12 per battalion and one per combat engineer platoon leader.

The portable computer unit (PCU) and transportable computer unit (TCU) provide multitasking software resources for computations, graphics capability, word processing, and data-base management. They process and evaluate data and combat information.

The PCU and TCU are based on the Hewlett Packard 9000 Series 300 computers and are designed for extended field operation. The basic PCU contains a flat, 9-inch diagonal electroluminescent (EL) display, and a 107-key keyboard. The basic TCU features a 107-key keyboard and a color video board to support an external color monitor. The computers contain four Mbytes of random access memory (RAM), a 3-1/2-inch disk drive, and a 40- or 100-Mbyte hard disk drive. They operate on standard 115 to 230 volts AC power and vehicular power.

Engineer company command posts and engineer staff sections at maneuver command posts will receive the PCU. Engineer battalions will receive the TCU. Ancillary devices, such as large color monitors and printers, will complement the PCU and TCU at selected command posts. Army units, battalion and higher, will start receiving HTUs, PCUs, and TCUs in 1990. Engineer forces below the battalion level will receive their automation hardware in the mid-1990s.



Hardware and software systems will greatly enhance the ability of engineer forces to influence the outcome of future battles.

The Maneuver Control System (MCS) is one of five nodes of the Army Tactical Command and Control System. MCS will provide automated command and control to maneuver forces such as infantry and armor. Combat engineers fall under the maneuver control functional area and will use the MCS. A force level data base (FLDB) in the MCS will serve as an information pool. Information will enter the FLDB by standard message text formats, direct entry, file transfer, or the use of graphics.

The Commander's Situation Report (SITREP) uses formatted displays and information generated from data in the FLDB. The SITREP provides commanders and staffs with a common picture of critical battle information. It has three basic components—situation map, intelligence, and friendly resources.

The Maneuver Control System-Engineer (MCS-ENG) subordinate system is the engineer specific software that will operate with MCS. A pilot version of MCS-ENG, called the Engineer Command and Control System (ECCS), was fielded in April 1988. Among other functions, the MCS-ENG will give engineer commanders and staff officers the capability to rapidly conduct engineer staff estimates, maintain friendly and enemy obstacle status, calculate logistical requirements for engineer missions, and create river-crossing plans. MCS-ENG will provide engineers access to maneuver data within the MCS, and vice versa.

Hardware and software systems will greatly enhance the ability of engineer forces to influence the outcome of future battles. It will be a challenge to employ these technological advances on the battlefield. Engineer soldiers at all levels must meet these challenges to increase overall combat effectiveness.

Scenario continued: 2LT Liles takes his HTU and quickly enters the data needed for minefield logistic calculations. Almost immediately the terminal screen shows the requirements. Next, he updates the platoon status report, highlighting the lack of fuel. He then connects the HTU to the radio and transmits this data to the engineer company command post. The company commander diverts mines and a fuel truck to 2LT Liles. The company operations sergeant uses a PCU to transmit the remaining shortfalls to the brigade engineer. The brigade engineer uses a PCU to incorporate 2LT Liles' platoon requirements into the overall brigade requirement. The MCS-ENG determines priorities for logistics and resources via electronic medium. This allows rapid coordination with the engineer battalion TOC, the assistant division engineer, CSS elements, and most importantly, the maneuver brigade. The engineer battalion TOC shifts additional corps engineer assets to the brigade's area of operation. Within 2 hours a log pack is on its way to the high priority countermobility belt identified in the maneuver plan. The engineer company commander sends the arriving corps engineer platoon to the same location. As the obstacles are completed, 2LT Liles uses the HTU to report the status to his commander, who disseminates the information through maneuver and engineer chains of command. As 2LT Liles finishes the last report, he turns and sees a long column of M-1 tanks moving through the snow on its way to wreak havoc in the enemy's rear.

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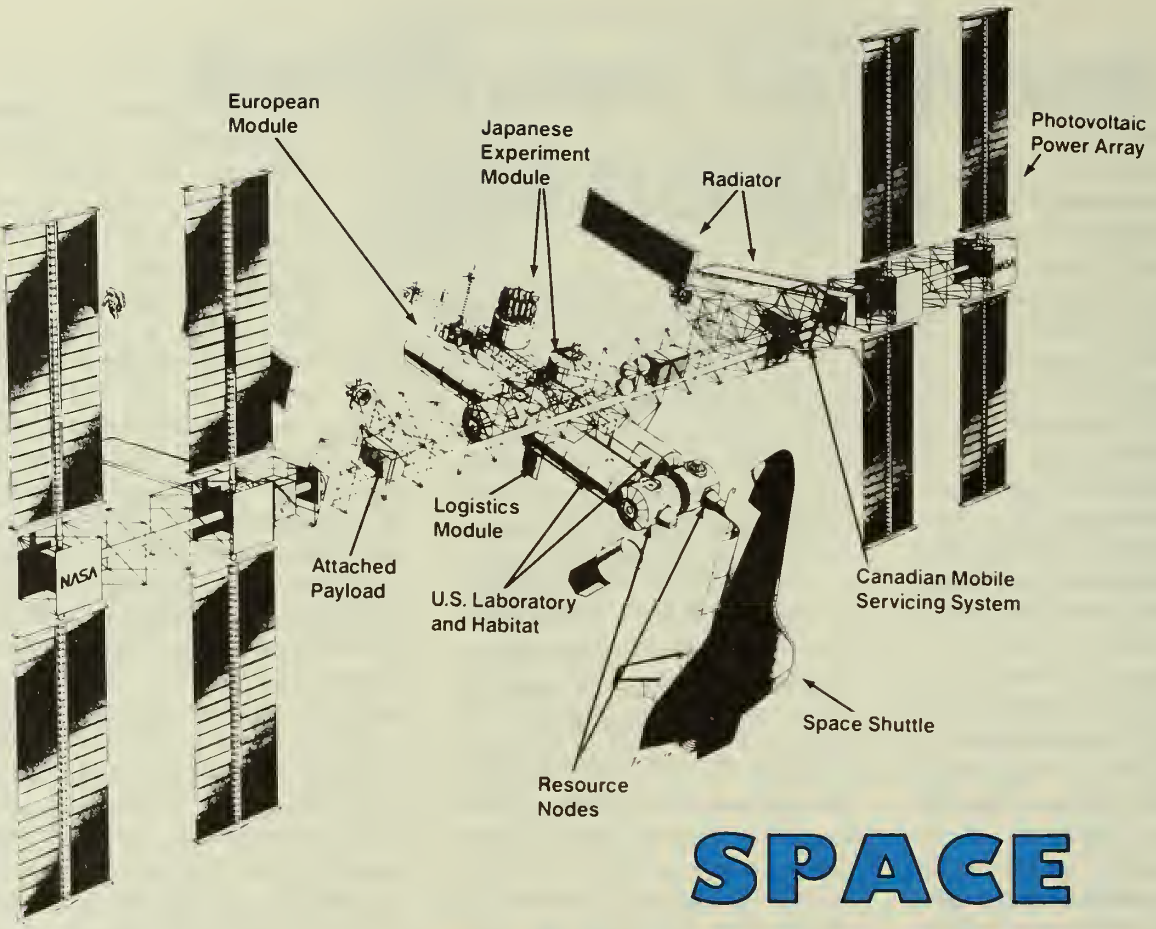
CPT Vincent Harackiewicz is a project officer at the Directorate of Combat Developments, U.S. Army Engineer School. He received a commission from Worcester Polytechnic Institute, and has a B.S. degree in mathematics from Framingham State College, MA.



Art courtesy of NASA

SPACE CONSTRUCTION

by MAJ Raymond E. Bailey and Mr. Alvin Smith

In November 1987, Lieutenant General E. R. Heiberg III, then Chief of Engineers, signaled the Army's need to resume a leadership role in space. In a letter to the Military Review called "Castles in Space," LTG Heiberg said, "Looking to the 21st century, space is not an option for the Army; it is a necessity."

Since that opening salvo, the U.S. Army Corps of Engineers and (by its close association with the Corps) the Army Engineer School have been preparing to fulfill LTG Heiberg's dream of "...extending into space the overall purpose of our corps—quality, responsive engineering services to the nation in peace and war—even though the ultimate mission of the Army will continue to be on terra firma."

Actually, the Army was involved in space prior to 1987 but had left the main thrust of the space construction effort to NASA and the Air Force. To date, the Army's principal involvement in the space construction program has been to study the requirements and to participate in conferences and meetings on space construction.

In August 1988, the Corps of Engineers and the American Society of Civil Engineers co-sponsored a conference in Albuquerque, NM, called "Space 88: Engineering, Construction, and Operations in Space." The conference was designed to encourage and stimulate the development of the technology and expertise required for space construction by drawing upon terrestrial experience in engineering construction in harsh environments.

The Army has participated in experiments included on previous space missions and released two studies on space construction in 1987. The first, "State-of-the-Art Technologies for Construction in Space: a Review," concludes that the construction of large space structures (LSS) is an immature, but emerging, technology. The second study investigates design concepts for large space structures to support military applications. NASA's program for space station development is the only current program dedicated to providing an LSS.

What is the Army doing to help NASA fill the void in space construction technology? The Army's initial involvement in LSS technology came on a 1985 shuttle flight. During that flight, Army astronaut Brigadier General Robert Stewart participated in the EASE/ACCESS experiment. Developed by Dr. Martin Mikulas (NASA-Langley), the experiment involved the assembly of an erectable 45-foot truss in space. This was the first and only space test of a structure joints system.

Realizing the potential offered by the EASE/ACESS experiment, the Construction Engineer Research Laboratory (CERL) was designated as the Army's lead agency in LSS construction in November 1986. As the LSS lead agency, CERL is charged to develop technology for construction in space. Through this laboratory, the Army has submitted several space construction experiments to the Department of Defense's Space Test Program that are based on earth studies of methods to coat materials in a vacuum. According to Dr. D. L. Stephenson, CERL principal investigator, these experiments are planned for future space missions. They examine a process for developing containerless coatings to protect LSS from damage caused by such hostile space elements as high velocity atomic oxygen and increased ultraviolet radiation.

The Corps of Engineers, the nation's construction expert, has picked up the gauntlet of leadership in developing technology for space construction, especially as it concerns military LSS. The Engineer School has taken a leading role in Corps space activities by including space missions for engineers in future concept documents and master plans. The school participates in all Army space planning meetings and working groups. Plans are underway to introduce basic and advance course students to the possibility of using space systems to support land combat operations. School personnel also review, support, and monitor research and development efforts at the four Corps of Engineer laboratories.

Although the Army and NASA have similar interests, military LSS will have substantially different requirements than those proposed by NASA. For example, current LSS designs for NASA have considerable inherent flexibility. This feature may cause disturbances in which the entire structure vibrates for long periods due to normal operations, such as shuttle dockings or movement of equipment or astronauts within the structure. Long periods of vibration may be acceptable for NASA's needs but are unacceptable for military needs. Military platforms and structures must be extremely stiff and dimensionally stable. Natural frequencies of about 20 hertz (hz) are needed for military LSS, while 1 or 2 hz are adequate for the proposed NASA design. Military LSS also require very short settling times (as low as one second) after a disturbance.

"Looking to the 21st century, space is not an option for the Army; it is a necessity."

Thermally induced disturbances are likely to occur as an LSS passes from sunlit to dark portions of orbits or when one part of the LSS is shaded by another. These distortions can be largely controlled by using the near-zero coefficient thermal expansion material offered by certain composites. Insulation and reflective coatings may also help control such distortion.

To the maximum extent possible, passive (designed in) vibration damping provisions should be included in military LSS systems. The probable complexity of active systems and controllers may make them unreliable and add substantially to launch weight. The long-term durability of active damping systems is questionable.

Specific operating systems, such as sensors, will dictate required performance parameters for the support LSS platform. The design and construction of the LSS must be responsive to operating system needs, requiring close interaction between operating system developers and LSS providers. Although we cannot foresee every possible option, it seems certain that compromises will be required. Since operating system performance is paramount, sacrifices in LSS weight, packing density, component redundancy, and cost may be needed to achieve the necessary stiffness and stability. Such compromises must be anticipated so contingencies can be provided.

Early definition of mission parameters will be necessary because the environmental effects of space differ considerably from place to place. Operating systems and their support LSS platforms will be subjected to very hostile conditions. Construction of LSS platforms in space will be required whether they are deployed or erected; in either case, a construction specialist will be required at the site. Remotely controlled devices maybe used, but true robotic operations in space construction are unlikely for several years. Regardless of the construction system used, elaborate training will be required and every possible contingency must be anticipated.

Space qualification and certification must be performed on every material, component, tool, subassembly—virtually everything going into space. In some cases this process can be extremely slow and costly. Military systems may avoid some constraints by standardizing components and defining or assigning different risk acceptance than presently used by NASA.

What needs to be done? The requirements for an Army LSS remain undefined. Although specific requirements are absent, much can be done to ensure the Army can provide a much better response, both in quality and time, as the needs emerge. The logic is simple: The extreme detail to which LSS projects must be planned, the high reliability and assurance of mission success, the high cost, the training and contingency planning, and other factors dictate extraordinarily careful planning. Each phase of the design, construction, and operation process must be thoroughly planned and documented to reduce the failure probability to nearly zero.

The steps in constructing an LSS are similar to those associated with any complex facility. However, the inhospitable, possibly hostile, environment will allow no adaptations of components on site and only very limited adaptation of procedures by construction personnel. Material selection must provide for durability, maintenance and repair, and logistics support to the platforms and operating systems. Many detailed plans must be made using algorithms, modeling or simulation, checklists, and similar devices.

No one knows all of the details that must be included in LSS plans, although NASA, the Air Force, aerospace contractors, and academia generally recognize that much work remains to be done. It is also agreed that LSS construction studies must start now and continue, even though actual space construction is several years away.

Everyone with interests in space should be involved in the planning. Each researcher, materiel developer, combat developer, operator, planner, executer, and user can contribute to the success of the mission. Organizations such as NASA and the Air Force have much data that can be used to plan space missions. Because there is no such body of knowledge or expertise on LSS construction, it is essential that everyone interested in LSS construction technology work together and share information.

Each participant must keep abreast of the technological developments of others. Construction planners, for example, must keep up with operating system developments, design techniques, materials, transport vehicle options and requirements, and training procedures. All pertinent factors must then be integrated into the construction plan.

Just as the Army topographic engineers developed the nation's infrastructure on terra firma, today's Army engineers must continue that pioneering spirit as full partners in the development and use of space.

MAJ Raymond E. Bailey is Senior Space Officer, Directorate of Combat Developments, U.S. Army Engineer School. He has served in command and staff assignments in the 1st and 18th Engineer Brigades. He has served in space assignments in the U.S. Army Engineering Topographic Laboratories and in the Army Secretariat. MAJ Bailey has a B.S. in geological engineering from the Colorado School of Mines and a M.S. in geological engineering from the University of Missouri-Rolla.

Mr. Alvin Smith is team leader, Space Engineering Team, Engineering and Materiels Division, CERL. He has worked as a supervisory materiels engineer and research scientist for more than 20 years. Mr. Smith has a B.S. in chemistry from Cumberland College, Kentucky, and a M.S. in theoretical and applied mechanics from the University of Illinois.

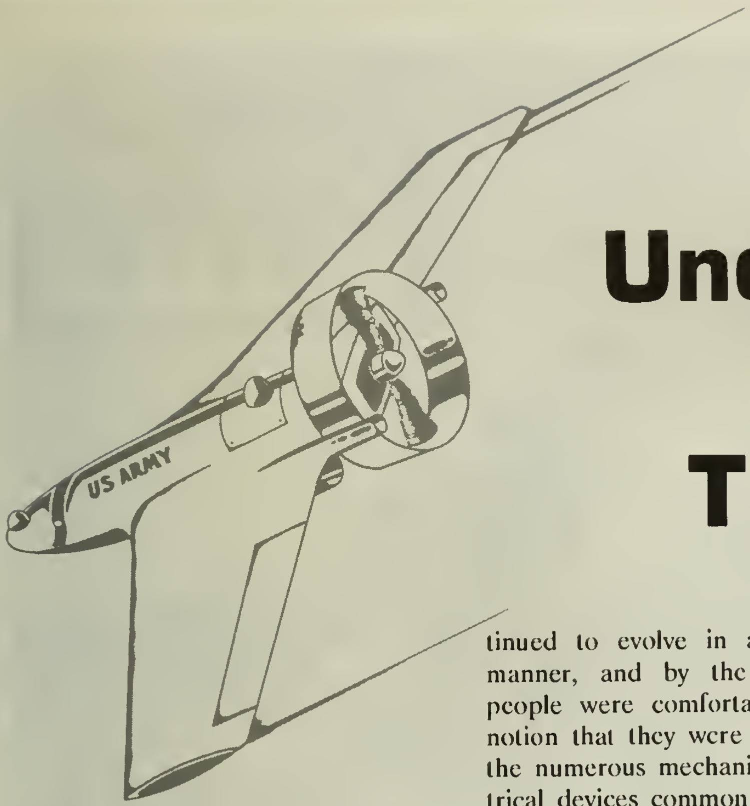
AMIDARS (continued from page 15)

The system currently is on hold pending Department of Defense approval. An artist's concept of how the system can be configured to evaluate real-time imagery analysis is shown in the illustration on page 15. The TIEDS will include a commercial vehicle similar to a van with equipment to record, manipulate, and display the high resolution line scan imagery. The system will have a host computer that performs housekeeping and control functions and supports several station high-speed image processors. When developed, MICAP will be an integral part of the TIEDS. Four workstations in TIEDS will perform all of the functions. Each workstation will have two monitors, one monochrome and the other in color. All displays will be capable of supporting a screen resolution of 12,800 x 1,024 pixels. Workstation capabilities will include on-screen target highlighting, edge enhancement, magnifying glass, and on-screen measuring.

A laboratory TIEDS simulator is being developed at BRDEC. The simulator will test processing technologies before a prototype is fielded. A real-time AMIDARS link with the user or operator will not be available until a fielded version of TIEDS is developed.

Development of all AMIDARS system components will continue. A demonstrator for the sensor is being tested, and delivery of a MICAP demonstrator is expected in 1991. TIEDS is on hold, but a facility to test system output is being developed. The U.S. Army Engineer School and the intelligence community are coordinating efforts to ensure support of this vital standoff target detection technology. These groups hope to field real-time image processing equipment in 1990.

Mr. Terilee Hanshaw is a physical scientist in the Countermine Systems Directorate at Belvoir Research Development and Engineering Center. A graduate of the California State University, Sacramento, he has participated in countermine systems analysis and technology base activities.



Understanding Robotic Technology

by Dr. Robert A. Sickler

Since the dawn of time man has been on a perpetual quest for new technology, often motivated by a desire for power and wealth. The drive to acquire new and more powerful technologies is best portrayed by man's endeavors on the battlefield. People with only stone clubs needed spears to better defend themselves or perhaps gain easier conquests. Soon the predominance of the spear in gaining victories was replaced by the bow, and then the bow by the gun, and ad infinitum. The history of man and technology, as portrayed through man's affinity toward warfare, reveals a key principle: Only those who totally embrace the principles of new technology survive.

Embracing new technology is not easy; embracing revolutionary technology can be almost impossible. Fortunately, revolutionary advancements in technology that have a widespread impact on society are not common. For example, following the industrial revolution most technology underwent a slow and methodical metamorphose. Because change was slow, the impact on the user was minimal. Technology continued to evolve in a predictable manner, and by the 1970s most people were comfortable with the notion that they were in control of the numerous mechanical and electrical devices common in the workplace. Oh, there were hints of machines doing things for themselves, but it was a far-off dream; a dream that had little part in the average person's life.

Only those who totally embrace the principles of new technology survive.

Mechanical and electrical technology had become mature, but scientists were rapidly unlocking a new technological door. When that door opened, changes in the technology of semiconductors and large scale integration came like a whirlwind. This new technology gave birth to systems such as microcomputers and microcomputer control. As a result, people were confronted with a rate of technological change unheard of since the industrial revolution. Soon this modern revolution became more than just the talk of scientists, and users were faced with the issue of "learn the new technology or fall behind."

Today, technologies such as computer-aided automation, robotics, and artificial intelligence are becoming the new wave of development. Those who understand the role of these advanced and emerging technologies are making it their goal to ensure that battlefield deficiencies are not addressed by outdated methods. So important is the issue of developing high technology military systems that it is now part of the global policy of competitive strategies.

If the U.S. Army is to meet the demands of AirLand Battle-Future, materiel and combat developers must ensure that new systems capitalize on emerging technologies. To accomplish this, the developer must strive to understand the capabilities and limitations inherent with the technology in question. For example, when planning the role of future robotic systems, TRADOC developers must understand the technology associated with the system. Otherwise, they will have a limited ability to determine how that technology will affect system performance.

For developers of robotic systems to work effectively, they must understand five key technological areas. The first area concerns the mechanical automation of the machine. In this context, automation implies that a mechanical function is performed without human intervention. For robotic systems, this entails automated movement of the base or support structure of the device and

The teleoperational John Deere 690C excavator typifies future robotic systems.

automation of the manipulator or arms attached to the base. For any piece of equipment, the base of the machine is the wheel- or track-mounted chassis, and the manipulator is the boom supporting a tool or gripper assembly.

Both of the mechanical subdivisions can be automated. However, automation of the manipulator generally results in the greatest increase in machine performance. This is true because most of our systems work intensively in a quasi-stationary position, such as in material handling. Automation of the chassis will result in a substantial increase in efficiency only when the major task of the system is associated with moving the equipment over long distances, as in material transportation. However, when designing a new equipment system, the possibility of future base automation should dictate general base configuration and should be part of the managed material change plan.

The second area that must be understood is automation of the power source or engine of the system. Automation of the power source probably is the most difficult to develop. Anyone who has tried to start a car on a very cold day or has had their car stall in traffic can appreciate the complexity of the internal combustion engine. Thus, if a large system is to be navigated over long distances, a very complex control system must be provided to automate starting, stopping, and engine control. If the equipment is not to be automated for long distance navigation, there is little need for an automated power supply. An operator can be responsible for driving the machine to the work site and initiating operation. The machine is responsible only for shutting down at the end of the work cycle.

Large internal combustion engines, although the most powerful, are not the only power source associated with robotic systems. Where the mission can be performed with small and light-weight equipment, machine motion can come from electric motors. Although they have the advantage of being easy to automate, electric motors have the disadvantages of limited load-carrying capability and limited travel distances. Missions that do not require internal combustion engine automation are tasks that can be performed from a relatively stationary position.

A robotic device that works from one location can receive its power via an umbilical cord attached to a remote power source. In the beaten zone of a battlefield, it will be impossible to maintain the integrity of any physical linkage between a machine and its power supply. However, in rear areas where quasi-stationary or stationary systems are employed, robotic devices probably can be powered by a remote power source.

All automated systems must have a method that allows them to see or feel. This third area of robotic

The ground vehicle portion of the Marine Corps' GATORS program uses visual and infrared sensors for navigation and control.

technology is often described as sensory input. It is a controlling factor in obtaining complete machine automation. There are two types of sensors: those used to gather information to aid in navigation, and those used to determine manipulator position. This subdivision is needed because the distance associated with chassis navigation is measured in tens of meters, and the distance associated with manipulator control is measured in tenths of a meter. Also, because the manipulator's end effector (gripper or tool) will make contact with things in its work space, the end effector must be sensitive to touching pressures and gripping pressures.

Manipulator sensors have an almost infinite variety of sensing tools that can provide input for arm positioning and end-effector gripping. These range from simple optical shaft encoders that indicate manipulator joint rotation to pressure-sensitive skins that control the amount of pressure generated in the grip of a robotic hand. One of the most sophisticated tools for manipulator control is three-dimensional sensing using visible light. This tool's method of operation is very similar to that of the human eye. In this method, two cameras generate a three-dimensional image of the work space that includes the manipulator. As the manipulator arm moves in the work space, its position is traced in the visual image and corrections are made to bring it into proper position. This method of manipulator control currently is limited by the speed at which the visual image can be processed by computational systems.

Current research in vehicle automation indicates that the primary sensor mechanism for chassis navigation will also use visible or nearly visible energy. Although the sensors used to obtain visual images are not very complex, the computer algorithms used to understand what the sensor sees are extremely complex. The computational methodology for vision recognition has advanced beyond the capability of existing computational machines. In other words, the software is becoming too sophisticated for existing computers to run. Before real-time machine vision for autonomous vehicle navigation becomes a reality, new computer science fields such as parallel processing or neural networking must be developed. When this happens, the problem of autonomous navigation will be almost eliminated.

Machine control is the fourth technological area in the overall design and use of robotic systems. Three generally acknowledged subdivisions of control are—

- remote
- cyborg
- autonomous

Remote control, the simplest form, involves relocating the operator away from the equipment to a position some distance from the machine. At this location, the operator controls the machine with signals sent through a physical link or by radio frequency communication. Continuous mining machines, widely used in the coal-mining industry, are an example of mature remote control technology. Many military related research programs are also pursuing this type of machine control. Although remote control falls under the heading of automation (robotics), it employs none of the concepts considered by the average person as true robotics.

Cyborg, a more advanced form of control, means that man and machine (computer) share control of the equipment. The Tank and Automotive Command (TACOM) is developing a rudimentary form of cyborg control. TACOM's program, called the Robotic Command Center (RCC), is designed so that one man can control two or more robotic vehicles. This research is centered on the concept of computer-aided remote driving. In this process, the operator plots a path of limited distance for the robot to follow. Once the command is given, the robot follows the prescribed path without help from the human.

Cyborg control is the most prevalent method of robotic vehicle automation in the military today and probably will remain so in the near future. In time, however, cyborg automation will be replaced by autonomous control. For a system to have autonomous control, the machine must be capable of performing all of its functions without human intervention. Sensors and control systems with the sophistication necessary for this level of autonomy already exist. Unfortunately, we lack computers advanced enough to use these sensors to make control decisions comparable to those of a human.

The machine used to control robotic functions is the fifth and last component of robotic technology. Currently microcomputers or minicomputers, programmed in a high-level language, are used to generate control signals. The signals used to control robotic motion may be a sequence of programmed outputs that occur in chronological order or, in more advanced systems, they may occur as a response to sensor input. In either case the output is determined by standard fixed programming logic. As a result, the machine cannot make rational responses based on abstract logic.

Robotics is used in this article as an example of advanced and emerging technology that developers must understand.

To accomplish any resemblance to the human thought process, a computer must have artificial intelligence (AI) capability. AI is a new computer methodology that simulates rational thought through a human-like, decision-making process. AI and computers that process AI software were alluded to in the discussions on sensors and control. Through the aid of this emerging technology, a truly autonomous system can be built that will perform its mission on future battlefields without human intervention.

Robotics is used in this article as an example of advanced and emerging technology that developers must understand. However, the rationale for understanding robotic technology is true for any system. In the past, technology associated with a new material system was similar to the technology associated with the old material system. Because technology changed only slightly, operational characteristics changed only slightly. Changes in operational characteristics were slight, and developers could easily visualize uses for the new material system on the battlefield. Today, however, some technologies are changing drastically. As a result, the operational characteristics of systems employing this new technology also change drastically. With so great a change in operational characteristics, it is difficult for developers to visualize uses for a new system on the battlefield.

It is hard to comprehend why people would resist new technology. Perhaps it is because they are comfortable with the old technology. Whatever the reason, we must change. With current budget constraints, we cannot afford the luxury of developing systems with old, familiar technology. Systems built with old technology will be outdated before they ever reach the field. A developer who understands a new technology can use that knowledge to develop operational characteristics that maximize a system's effectiveness on the battlefield.

Warfare may seem to over dramatize the role of advanced and emerging technology. But today, as we stand on the threshold of a quantum leap forward in technology, the principle of survival is still true. New technologies such as robotics, artificial intelligence, directed energy weapons, composite materials, aerospace based weapons, and smart munitions will drastically alter the battlefield of tomorrow. The nation that first develops and fields these new technologies will dominate the battlefield. Considering the present world situation, we must not allow American application of high technology to fall behind the efforts of nations that threaten world peace. We, as a nation and as part of the military community, must devote the time and effort needed to understand and embrace the use of advanced and emerging technologies if our nation is to remain a viable force in the free world.

(biography on page 20)

"Wars may be fought by weapons, but they are won by men. It is the spirit of the men who follow and the man who leads that gains victory."

GEN George Patton

Engineer Problem

You are in charge of an engineer company in support of division rear area operations. The commander expects that the threat level in the divisional rear area may move to Level III. If the area is attacked, the enemy's progress must be hindered to allow time for defense forces to react. The commander directs that you emplace a deliberate protective minefield according to the following data:

Front: 960 meters
Desired density: 2 - 3 - 4
IOE representative cluster composition: 1 - 2 - 2
Antihandling devices: 15 percent
Standard marking fence on 4 sides
Depth: 210 meters

The following equipment and logistics are available to your unit:

2-1/2 ton cargo trucks
M15 AT mines
M16A1 APF mines
M14 APB mines
Barbed wire
U-shaped pickets

Calculate the following requirements to accomplish your mission:

Part I - Determine the number of mines required

- Number of AT mines
- Number of APF mines
- Number of APB mines

Part II - Number of regular lettered strips

- Number of strips

Part III - Calculate the number of man-hours required

- Man-hours of effort

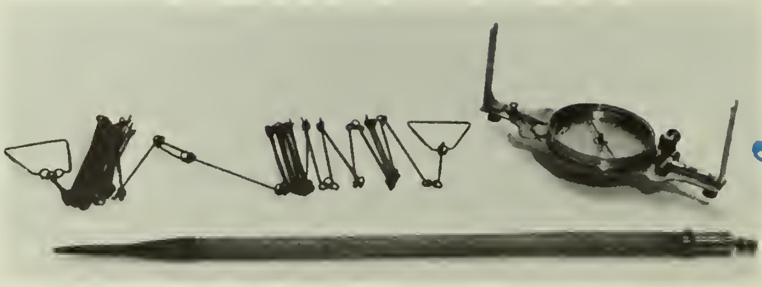
Part IV - Determine required amount of fencing

- Fencing (in meters)

Part V - Determine the number of truckloads

- Number of truckloads

For solution, use FM 20-32, Appendix B, page 239.
Engineer Solution on page 47.



A Map for the Mappers

by LTC Robert F. Kirby

On July 5th, 1988, Army topographic engineers celebrated 150 years of nation building service. They looked back at a heritage encompassing the exploration and mapping of our country by men such as Captains Meriwether Lewis and William Clark, and Lieutenant John C. Fremont, through the development of the inland waterways, the preparation of maps and terrain studies supporting commanders in wars, leading technology innovations, and the establishment of mapping programs for developing nations. In 1988 it was appropriate to reflect on this legacy of accomplishments. It was also a year to set the baseline and azimuth for the future.

The Engineer School, fulfilling its TRADOC proponency for Army topography, established the Department of Topographic Engineering to build on the legacy of the past. The department's mission is to assure the horizontal and vertical integration of sound doctrine and training, force structure and design, and equipment development for topographic engineering for the 21st century. (See ENGINEER Professional Bulletin, November 1988). To navigate into the future, the mappers must know their present location, their objective, and the best route to follow; they need a mission-oriented terrain analysis. MG Schroeder tasked the Department of Topographic Engineering to prepare this document in the form of the Army Topographic Engineering Master Plan. The plan will not be published until it has been thoroughly coordinated within the Army and other Department of Defense components, but a preliminary draft concept was briefed during the Army Topographic Conference in October 1988. Some of the key elements of the draft concept that are shaping the master plan are explained here. The key elements are doctrine, organization and force structure, training and leader development, equipment, and technology research and development.

Doctrine. As AirLand Battle doctrine evolves to AirLand Battle-Future over the next 20 years, the continuing focus of topographic engineering doctrine must be to ensure the warfighting commander knows the terrain and uses it advantageously in successfully conducting the battle. The doctrine must provide the essential sense of place. The modern warfighting commander must understand a complex physical battlefield environment which incorporates terrain and weather and their impacts on maneuver and fires. Within this environment, the commander must assess the enemy's intent, develop plans, and apply dynamic weapon systems and joint operations to achieve victory.

The broad scope of AirLand Battle doctrine demands integrated knowledge of the terrain and its associated weather effects to gain agility, initiative, depth, and synchronization. To be of value, this knowledge of the battlefield must be communicated in a timely manner and in a form that supports warfighting decisions.

At the 1988 Engineer Commanders' Conference, General Vuono challenged engineers to be the terrain experts and to impart that knowledge to the rest of the force. He believes terrain decides maneuver at the tactical level and allows the concentration of power at the operational level.

Organization and force structure. Topographic engineer units provide the Army's tailored terrain product and information contribution to mapping, charting, and geodetic support. Topographic engineer support begins with the Defense Mapping Agency's (DMA) standard products and services. Topographic engineers are advocates for Army commanders and work as meaningful partners in DMA's program to ensure sustained warfighting support within available resources. They contribute to deterrence daily and must be a visible part of the force structure and the decision-making process prior to and during the employment of combat units.

Topographic engineer soldiers in the division terrain teams and the divisional engineer commanders are the first links to the commander. Behind these soldiers are other topographic soldiers who will ensure the reliability and availability of special topographic information in both position and content accuracy. The logistics system and supporting communications will provide direct access to and supply of the standard mapping and geodetic products and information originating with DMA and other DOD systems. An Army topographic agency seems necessary to provide an intermediate topographic support level between the field topographic engineer units and the base plant production capabilities of the DMA. The Engineer Topographic Laboratories' current Terrain Analysis Center might evolve to fill this role.

Training and leader development. The Engineer School will take charge of training service unique topographic systems to integrate AirLand Battle and topographic engineer doctrines. It will establish an acquisition, professional development, and assignments program for topographic engineer soldiers. It will formulate the training for every engineer officer so they can advise and support their maneuver commanders in shaping the battlefield with all engineer resources. The school will also recommend terrain training and develop topographic scenarios for integration into other Army schools.

Equipment. To meet the demands of doctrine, topographic engineer equipment will change from its current large signature, limited transportability systems that produce hardcopy, graphic terrain products by time consuming, labor intensive methods. Part of this equipment will be replaced with digital systems capable of storing, synthesizing, managing, and disseminating terrain information from digitized hardcopy terrain products. They will also provide rapid, full size, and color reproductions of limited quantities of hardcopy terrain products. Position and navigation requirements will combine classical and remotely supported instrumentation within topographic capabilities and independent aerial and ground maneuver and weapons systems.

Future topographic support equipment will be compact, highly mobile, and transportable digital systems. These systems will collect, synthesize, manage, transform, reproduce, and disseminate integrated terrain and weather effects, environmental and positional/navigational information, and products from all sources. Primary support will be from a standardized geographic information system data structure. Where appropriate, these capabilities should be provided as tailored and imbedded technology within command and control, maneuver, and weapons systems and processes to ensure freedom of action in executing the battle. Topographic engineers will be responsible for the integrity, accuracy, and currency of the standard geographic information system in conjunction with the DMA, supporting weather systems, and the joint tactical fusion intelligence process.

Technology research and development. The Engineer School will look to the Engineer Topographic Laboratories to provide technical support and integration. This is the essential relationship of a combat developer to its materiel developer. Technology, research, and development efforts should focus on achieving the equipment, processes, and data bases to obtain the doctrinal support capabilities which will give the commander knowledge of the battlefield. Associated terrain and weather environmental and related effects technology should be collectively pursued and demonstrated. Because of the fast pace of topographic and weather related technology, applicable technology will be introduced to topographic engineers and others for limited operational use. This will provide insight to training and materiel developments, and enhance operational responsiveness and readiness.

Topographic engineering has a proud heritage, and its support is critical to executing AirLand Battle doctrine. It must focus on warfighting and evolve to support AirLand Battle-Future. While embracing the digital technology revolution, it must tailor classical topographic services to fill the gaps and provide appropriate reserve capabilities. Coordination with the DMA, other services, and the weather and intelligence communities is essential. Technology must be integrated and directed to give battle oriented decision aids that enhance the commander's knowledge of the battlefield. Upon completion, the Army Topographic Engineering Master Plan will establish the starting control, proposed traverse route, side checks, and a closing control. Some adjustments may be required, but if we measure our error by the deterrence and warfighting success of the commander we support, we'll be within acceptable tolerances.

LTC Robert F. Kirby is Director, Department of Topographic Engineering, USAES. He has a B.A. in geography from the University of Illinois and a M.S. in geodetic science from Purdue University. He is a graduate of EOBC and EOAC.

STAR TRACKER RESEARCH

by Ms. Celine M. Childs

U.S. Army Engineer Topographic Laboratories (USAETL) will greatly contribute to Army space technology as a result of its expertise in star pattern identification and spacecraft attitude determination. This technology is referred to as the Star Tracker experiment. In May 1986, USAETL was chosen as the principal investigator for this experiment, which was selected by DOD for a Spartan unmanned, shuttle-launched and retrieved spacecraft.

The Star Tracker experiment will be delivered to NASA in June 1989 for integration with the Spartan spacecraft. Technical support for the detailed experiment package design and integration is provided to USAETL by the Johns Hopkins University Applied Physics Laboratory in Laurel, MD. The experiment is designed to research the capabilities of solid-state sensors as star trackers for precise autonomous attitude determination for spacecraft. The goal is subarcsecond pointing.

Unlike the film-based stellar sensors used with the lunar orbiter system in the 1960s, the Star Tracker will employ solid-state star sensors using a charge-coupled device (CCD) focal plane. The CCD, a relatively new technology, relies on sensing the light intensity of objects to obtain visual information. It offers greater dynamic range capabilities and faster readouts than film-based stellar sensors.

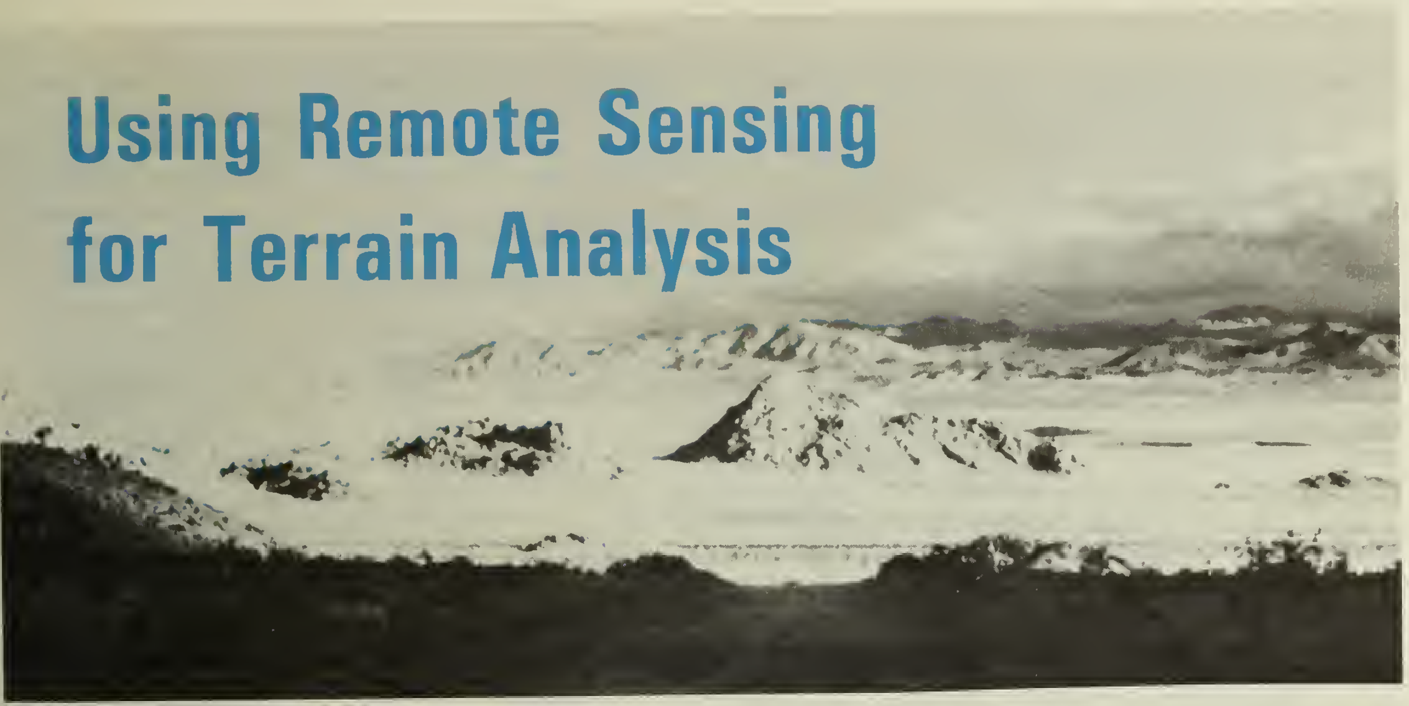
The Star Tracker will also gather data for a range of parameters to characterize its performance. These will be analyzed after the flight to refine the algorithms used, or to design new algorithms for star pattern identification and attitude determination for future missions. Studies to date have used simulation of an attitude sensing system. These studies show that accurate orientation information is accessible and will help scientists build a highly redundant, autonomous attitude determination system. This system will be capable of real-time attitude estimation with less than one arcsecond root mean square error.

Advances in Star Tracker technology will allow for progress in spacecraft autonomy, particularly for high-precision, real-time pointing. Spacecraft autonomy is used for mapping, charting, and geodesy.

The Star Tracker technology will alleviate many problems associated with stellar observation, such as background sky brightness, atmospheric disturbances, and refraction, which distort the star field.

Ms. Celine M. Childs was recently employed as a public affairs specialist at the U.S. Army Engineer Topographic Laboratories, Fort Belvoir, VA. She is a graduate of Lock Haven University and has a bachelors degree in liberal arts.

Using Remote Sensing for Terrain Analysis



"Terrain and weather have more impact on battle than any other physical factor" (FM 100-5)

by Dr. M. Merrill Stevens

The battlefield of the 21st century will be more challenging than those of the past. Its topographic boundaries will be less well defined, with greater areal extent, and so will have a propensity for more varied terrain conditions. We can also expect more obscurants to visibility and greater lethality. Engineers, the terrain experts, are preparing to meet this challenge.

A keen knowledge and the ability to readily assess battlefield environmental conditions is a force multiplier to the battlefield commander. Terrain conditions are critical in military planning and operations. As LTG Henry J. Hatch, Chief of Engineers, has said, "Terrain is neutral. Ignore it and it becomes your enemy. Use it and it is your ally."

Ground reconnaissance, the most accurate means of evaluating terrain conditions, is not always possible because of inaccessibility and time limitations. Since future military operations are not likely to permit physical access to the battlefield and time will be critical, a remote means of evaluating terrain will be necessary. Remote sensing of the ground surface can also provide terrain information not immediately apparent from ground reconnaissance or by visual observation from the air. The use of remotely sensed terrain data from space-, air-, and ground-based sensors will help commanders see and assess the battlefield in time to affect the outcome of the battle.

On the 21st century battlefield, information gathered from remote sources will be integrated with information previously generated and stored in digital terrain data bases. These data will be processed on knowledge-based expert systems using artificial intelligence tools and advanced microcomputer and graphic display capabilities. Finally, the data will be disseminated to the battlefield commanders in time to influence their decisions.

Standard digital terrain data bases, under development, will provide the basis of the Army's land combat operations mapping, charting, and geodesy (MC&G) requirements. The real-time remotely sensed data will be merged with terrain data to enhance the standard data bases. Knowledge bases are being assembled which will characterize unique terrain features by processing germane sensor record signatures. Each feature signature will have geometric fidelity to allow the locations of militarily significant terrain features to be identified analytically. Hyperspectral (narrow band) and multispectral (multiple band) analyses will be used to extract information and monitor the physical surface conditions of the battlefield.

Several remote sensing techniques are being tested at U.S. Army Corps of Engineers laboratories. Engineers are analyzing and interpreting physical aspects of terrain for various applications.

Waterways Experiment Station (WES) personnel use satellite imagery to assess mobility. They are classifying land cover to gather information on modeling parameters such as surface roughness, slope, vegetation spacing, and visibility.

Engineer Topographic Laboratories (ETL) personnel are analyzing image patterns and spectral reflectance, luminescence, and radiometric measurements. These techniques are used to estimate cross-country mobility, predict dust generation, discriminate targets and backgrounds, and detect camouflage.

Cold Regions Research and Engineering Laboratory (CRREL) staff use multiband imaging systems to gather information on the surface conditions of snow, ice, and frozen ground. The information is then used to assess mobility and trafficability, evaluate mine emplacement, and locate water supplies.

In a study performed in conjunction with the Center of Remote Sensing at ETL, I used data obtained by remote means to predict the characteristics of selected desert terrain features. The purpose of the study was to estimate such militarily significant surface conditions as trafficability and susceptibility to dust generation.

The application was based on the assumption that each feature of the earth's surface, such as a soil surface, absorbs or reflects the radiant energy of the sun based on its physical and chemical properties. Similar to the analogy of the uniqueness of the human fingerprint, it is believed that everything in nature has its own unique distribution of absorbed and reflected radiation. Measurement of this reflected energy can be used to spectrally evaluate the physical and chemical properties of the soil. This measurement is a critical step in determining natural terrain conditions.

The soil characteristics responsible for the physical condition of the desert terrain in the study area were identified. When compared with the soil properties that can be spectrally measured, the following soil characteristics were similar: soil moisture, particle-size distribution, salinity and alkalinity of the soil, and clay-mineral composition.

The analysis, which proved successful, was performed to determine if these soil properties could be remotely detected under field conditions. This provided an indication of the physical properties of the soil pertaining to such conditions as trafficability and dust susceptibility. Results indicate that remote sensing can be used to gather information with greater protection for personnel and equipment while actually providing much more information than "that which meets the eye."

The 21st century battlefield commander will use remote sensing techniques extensively. These techniques will provide topographic engineering information on such militarily significant operations as trafficability, dust susceptibility, cross-country movement, camouflage, cover and concealment, selection of aircraft landing sites, and registration of inertial navigation systems.

Dr. M. Merrill Stevens is assigned to the Topography, Space, and C4 Branch of the Directorate of Combat Developments, U.S. Army Engineer School. She has a Ph.D. in geological engineering from the University of Missouri-Rolla and recently received a direct commission in the USAR as a 21C, Topographic Engineer.

Writer's Guidelines

Do you have articles, photographs, or artwork to submit to ENGINEER? Here are some tips.

Topic: We focus on combat engineering; however, any articles of interest to engineers are welcome. We include relevant historical articles that emphasize lessons learned from the past, and we provide a forum for progressive ideas.

Style: Write in active voice and be as concise as possible. Spell out all acronyms the first time they are used. Please give your article a title, too.

Length: Let your subject dictate length; generally, articles should be three to eight, double-spaced pages.

Photographs and artwork: Besides photographs and artwork that supplement the articles, photographers and artists can submit any work that may be of interest to engineers. We prefer 5 x 7 black and white, glossy photographs. Please include a caption and photo credit. Drawings should be legible, but do not have to be camera ready.

Departments: We are always looking for items for our departments—

- Engineer Update
- Personal Viewpoint
- Lessons Learned
- Past in Review

Engineer Problem: Please submit your challenging—but not too hard—Engineer Problems. Problems should be referenced to a manual but must be original. They should strengthen combat engineer skills, and be checked for accuracy.

Cover letter: When submitting material to ENGINEER, enclose a cover letter with your name, address, and phone number. Also, please include biographical information such as military and civilian education and past and present assignments.

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Chosin Reservoir Campaign

by CPT Robert R. Broadhead

During U.S. operations in the Chosin Reservoir Campaign of the Korean War, October to December 1950, Marine engineers were forced to improvise to accomplish their mission. Valuable lessons learned from this campaign may apply to warfare today and in the 21st century.

In October 1950, the 1st Marine Division began to move northward from the east coast of what is now North Korea in support of the X Corps. During debarkation of the division on the coast, the division's organic engineers, the 1st Engineer Battalion, removed mines on the beach, prepared roads, and constructed ramps for landing ships among other tasks. Three engineer companies were assigned, one each, to the three Marine regiments in the division. Headquarters, Service, and B Companies of the engineer battalion were in general support of division operations.

The division's northward route wound along a narrow road from coastal hills through increasingly rugged and treacherous mountains. In the first several days and miles, guerilla-like resistance by scattered North Korean units was fairly light and sporadic. The engineers concentrated their efforts on maintaining the main supply route (MSR). This task was complicated by the enemy's skillful use of obstacles. These were eliminated by the engineers, who depended heavily on the battalion's 18-ton and 27-ton bulldozers. Engineers bore a large burden of the enemy attacks as they concentrated on obstacle removal. They widened and improved the road in many places to accommodate armored vehicles. The engineers also constructed three airstrips for observation aircraft, maintained a narrow-gauge railroad that ran parallel to the MSR, took over sawmills to produce lumber and barrier material, and constructed facilities for the division support base near the port.

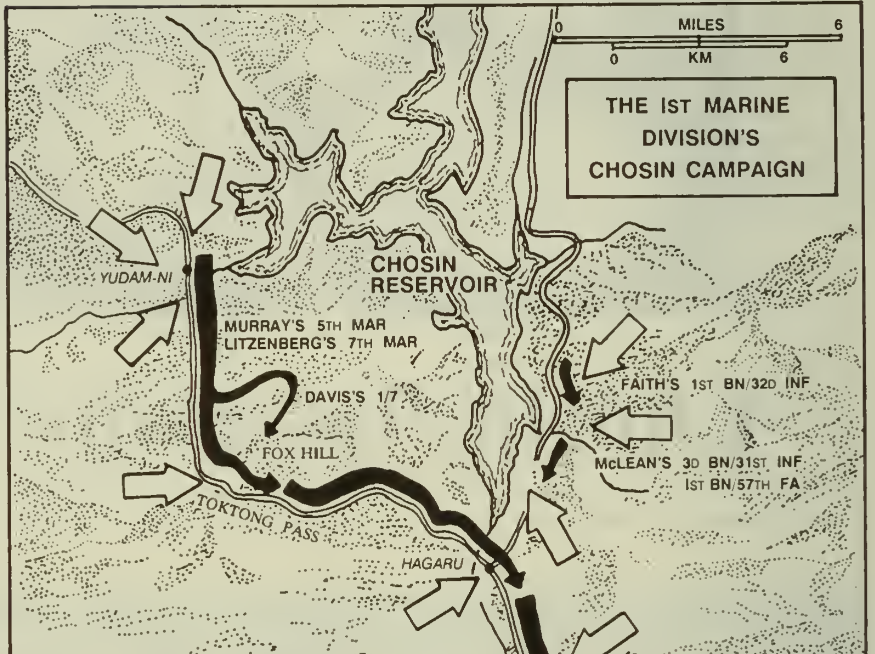
A few Chinese troops were detected in the last week of October during operations against some Republic of Korea (ROK) forces elsewhere on the Korean peninsula. The 1st Marine Division was first attacked by the Chinese on 2 November. Chinese forces launched a major attack that night on the lead Marine regiment, which was dug into strong positions in a perimeter at Sudong. When enemy assault waves broke through at several points, engineers from D Company filled the gaps. The next day, Marine close air support swung the momentum back to the defenders, wreaking havoc on the Chinese infantry. They established a pattern that would last for another month: defend the perimeter against mass attacks every night, and hold out until daylight when artillery and friendly Corsairs returned the advantage to the Marines.

As the division continued its way northward over the next two weeks, the weather became bitterly cold. The engineers constructed an observation airstrip at Koto-ri, repaired roads and bridges, and continued sawmill operations. They also laid mines, removed duds, and filled in as infantry on the perimeter at night. Concerns about the vulnerability of the division's supply line mounted as the line lengthened.

The lead regiment reached and passed Hagaru on 16 November and started constructing another airfield for C-47 transport aircraft. This airfield was located in a frozen bog. According to the manuals, a strip more than 7,000 feet long was prescribed at that altitude. Only about 4,000 feet were available, and pilots decided they could get by with that length. The Marine engineer battalion lacked enough heavy equipment to tackle the 90,000 cubic yards of cut and 60,000 cubic yards of fill in frozen earth. Therefore, engineer equipment from the 185th and the 10th Engineer Battalions, U.S. Army, were sent along the MSR to assist in the gigantic task.

The lead Marine regiment continued its advance and reached Yudam-ni on 25 November. Their hard-working engineers removed defended and undefended obstacles and spread sand and gravel along the MSR to keep the snow- and ice-covered roads passable for the heavy vehicular traffic. At the Hagaru airfield, the ground was frozen so hard that blades on the scrapers and bulldozers wore off quickly. Special teeth were welded onto the blades, but earth quickly froze on them, making the blades inoperable. Work continued on the strip around

All allied forces in the Chosin area were ordered to return to the coast because of the tremendous Chinese offensive.



the clock, with the field brightly lit by floodlights each night. The engineers also constructed and upgraded facilities in Hagaru, which was a supply base and future division headquarters.

An Army regiment from the 7th Infantry Division began to move northeast from Hagaru on 25 November to assume the sector east of the Chosin Reservoir. That same day, the Chinese forces began their main offensive. The Chinese had 120,000 troops in 11 divisions active in the Chosin area. Eight of the divisions were in direct contact with the 1st Marine Division all along the MSR and with the Army regiment.

Fierce assault waves struck everywhere on the night of 27 November. The Army regiment tried to return to Hagaru, but they had no engineer assets and could not bypass the many heavily defended obstacles erected along the escape route. Over the next five days the regiment was almost annihilated. Eventually only 1,050 out of 2,500 men and no equipment returned to Hagaru from that expedition.

At Hagaru, work continued on the airstrip day and night. The site had taken on an even greater importance after the Chinese offensive because the division depended on it for resupply and evacuation of wounded. All service troops, including engineers not working on the airstrip, were placed along the 4-mile perimeter. Every night for more than a week there were ferocious assaults by Chinese forces. The heaviest attack came on the night of 28 November. About 0100 on the 29th, the enemy broke through the perimeter and reached the still brightly lit airstrip. The engineer equipment officer, a 2nd lieutenant, led a group of D Company engineers in a counterattack and cleared the airstrip. The engineers then climbed back on their dozers and resumed work under the floodlights.

Engineers around the perimeter displayed as much gallantry as the Marine infantry in holding off the attackers. One engineer company, however, was temporarily overrun when they were unable to fire their weapons because of the cold. They had not learned how to maintain their weapons in these conditions. After dawn on the 29th, a composite force consisting mainly of engineer troops and led by an engineer platoon leader, counterattacked to retake a vital hilltop that had been overrun during the night. Engineer troops, both Marine and Army, also occupied significant portions of the perimeter at Koto-ri, further south. On the night of the 30th, engineer troops were again used as infantry in both defense and counterattacks.

"We are not retreating; we are simply advancing in another direction."

All allied forces in the Chosin area were ordered to return to the coast because of the tremendous Chinese offensive. The 1st Marine Division commander was determined to come out fighting with all men and equipment. He stated, "We are not retreating; we are simply advancing in another direction."

The Marine regiment at Yudam-ni began their fighting withdrawal towards Hagaru on 1 December, with an A Company platoon as the last out. They destroyed all supplies that had to be left behind. The platoon then established delaying positions behind the regiment on the MSR.

At Hagaru, observation aircraft and helicopters were already using the airstrip to evacuate the mounting numbers of wounded, and supplies were air-dropped into the perimeter. Although only about 40 percent of the strip was completed on 1 December, a trial landing by a C-47 was authorized. It hit, bounced, and finally stopped safely while the engineers who had worked on the strip for only two weeks cheered wildly. The big plane flew away 30 minutes later carrying 24 wounded and some badly needed parachutes. Its tail lifted off the 2,900-foot runway at the last moment, barely clearing hills to the south. Three more cargo planes landed that afternoon, and many more landed in the following days. The engineers continued to improve, extend, and maintain the airstrip. The enemy had lost the initiative; the Marines came out fighting, bringing their casualties and equipment with them.

The Marine regiment from Yudam-ni finally reached Hagaru on 4 December. They were led by the A Company engineer platoon, which had alternately cleared obstacles and manned rifles. Meanwhile, heavy Chinese attacks continued along the length of the MSR. The C Company Marine engineer platoon, repairing the railroad near Chinhung-ni, was totally cut off for almost a day before fighting their way back to the perimeter.

On 6 December the Marines finally began a breakout move from Hagaru, again led by a platoon of engineers. The Chinese efforts had abated during the previous days due to their tremendous casualties. They renewed attacks with a vengeance born of desperation at seeing the U.S. forces escape. Engineers used bulldozers up and down the "advancing" column to push aside equipment damaged by ambushes that blocked the narrow road. When the last Marines left Hagaru on 7 December, engineers set off demolitions to destroy anything usable left behind.

At the steepest mountain pass, the Marines encountered a serious problem—a bridge blown up by the enemy for the third time. The bridge was so badly damaged that it could not be repaired with timbers or steel treadway sections by normal means, as it had after the two previous attacks. Army engineers from the 58th Treadway Bridge Company, located at Koto-ri, were moved to the site, and treadway sections and lumber were airdropped to the column. By carefully planning and modifying normal construction methods, the bridge was repaired, and the column began to pass over it. However, a large engineer scraper suddenly cracked the centerboard, stranding the pan at a precarious angle. An engineer technical sergeant, an expert equipment operator, moved forward in the darkness past the halted column to move it. With his path illuminated by flashlights, the sergeant inched the vehicle onto solid ground and saved the bridge from total blockage. The bridge was quickly repaired, and the column continued to slowly fight its way to Koto-ri.

Meanwhile, the small airstrip at Koto-ri was converted for use by C-47s. The runway was lengthened to 3,300 feet. As engineers arrived, they were put to work on the strip or in the perimeter. Most of the column never stopped at Koto-ri but continued on towards the coast. Chinese resistance lessened because their soldiers were almost completely exhausted from battling the cold, terrain, and U.S. forces. The last U.S. troops finally pulled out of Koto-ri on 10 December, accompanied by a detachment from the 185th Engineer Battalion, which performed demolition work.

After a few more attacks on the column, the U.S. forces reached the port at Hamhung on 11 December. The engineers again assisted with port operations, as they had two months before.

The Chosin Reservoir Campaign ended on 14 December, when the last of the 1st Marine Division was loaded aboard ships. Engineer operations were vital to the successful withdrawal of the division, its supporting forces, and most of the equipment and personnel. According to the division commander's after-action report, "The withdrawal from Hagaru would not have been possible if the engineer operations had not been successful."

The Chosin Reservoir Campaign demonstrates that engineer forces are vital to the success of combat arms operations in modern warfare. Three key lessons are evident:

First, attempts to economize on the weight of equipment in engineer units assigned to light infantry divisions may be false economy in combat situations. The engineers were able to perform their combat engineering tasks and construction missions because of their organization and equipment. Tactics were almost entirely infantry. Tanks were almost useless in the mountainous terrain, but bulldozers, scrapers, cranes, sawmill components, and other construction equipment were vital to keeping the MSR open and to constructing the airfields. A vehicle like the M-9 Armored Combat Earthmover would have been ideal for reducing obstacles, but heavier equipment was needed for airstrip construction.

"The withdrawal from Hagaru would not have been possible if the engineer operations had not been successful."

Second, engineers must be aggressive and innovative. The officers and men of the engineer units were aggressive and applied innovative solutions to their unusual problems, such as debarkation on the beach, construction of the airfield at Hagaru, and repairing the blown bridge. In each case, a satisfactory solution was devised, although the solution sometimes violated procedures and safety precautions in construction textbooks. The 1st Engineer Battalion commander did not hesitate to undertake construction of the C-47 airstrip at Hagaru, although the task was well beyond the scope of the battalion, even under normal conditions. Work was completed when the ground was frozen and enemy forces were attacking the perimeter nightly around a brightly lit construction site. Engineers displayed initiative when they rapidly organized reinforcements as the enemy started to penetrate the perimeter. The sergeant showed initiative when he drove the scraper off the bridge, and units worked aggressively all along the MSR.

Combat in any theater in the 21st century probably will be fast moving and demand rapid, temporary, and innovative actions. Engineer leaders must be trained to think and act vigorously, to make good decisions quickly, and to act on those decisions energetically to completion.

Third, engineer units must be trained as infantry. The engineer units in Korea were constantly used as infantry soldiers, both on defense and in counterattack. In the future, all units, whether in the main battle area or in rear areas, probably will see enemy action. Trainers must be aware that engineers may be used as infantry while performing their engineer missions.

Those who do not learn from the mistakes of history are bound to repeat those mistakes. Also, those who do not profit from operations in history that were performed well will not benefit from those successes. The engineer operations in the Chosin Reservoir Campaign show that engineers are only as valuable to combat arms as they make themselves through their mental attitude, training, and equipment.

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Engineer Solution

Part I

- Number of AT mines: 2230
- Number of APF mines: 3404
- Number of APB mines: 4460
  - Front / 9 = IOE live clusters. (960 / 9 = 106.6)

IOE live clusters = 107 (round up)	AT	APF	APB
• IOE representative cluster x	1	2	2
number of IOE clusters =	x 107	x 107	x 107
number of mines in IOE	107	214	214
• Desired density x	2	3	4
minefield front =	x 960	x 960	x 960
mines in regular lettered strips	1920	2880	3840
• Subtotal of mines	2027	3094	4054
(B + C)			
• 10 percent excess factor	x 1.10	x 1.10	x 1.10
Total number of mines to order:	2230	3404	4460

Part II

- Number of strips: 6
  - Add desired density: 2 (AT) + 3 (APF) + 4 (APB) = 9.
  - Multiply line A by 0.6: 9 x 0.6 = 5.40 round up: = 6.
  - Multiply AT desired density x 3: 3 x 2 = 6.
  - Number of regular lettered strips required = highest number of lines B or C = 6.

Part III

- Man-hours: 1516
  - Number of mines / emplacement rate = required man-hours (always round up)
    Required man-hours for AT mines: 2230 / 4 = 557.5 (558).
    Required man-hours for APF mines: 3404 / 8 = 425.5 (426).
    Required man-hours for APB mines: 4460 / 16 = 278.75 (279).
  - Total requirements of A = 1263.
  - Multiply B x 1.2 = 1515.6 (round up) = 1516.

Engineer Solution

Part IV

- Fencing: 7000 meters
  - Formula for determining fencing:
    [(front x 4) + (depth x 4) + 320] x 1.4 = meters of barbed wire required.
    Substituting:
    [(960 x 4) + (210 x 4) + 320] x 1.4 = 7000 (round up if necessary)
  - Number of pickets = amount of barbed wire / 30.
    Substituting:
    7000 / 30 = 233.3 (round up) = 234.
  - Number of signs = number of pickets = 234.

Part V

- Number of truckloads: 30
  - Determine the number of mines per truckload.
    -AT mines
    102 cases / truck x 1 mines per case = 102 mines per truck.
    -APF mines
    111 cases per truck x 4 mines per case = 444 mines per truck.
    -APB mines
    113 cases per truck x 90 mines / case = 10,170 mines per truck.
  - Determine the number of truckloads per mine type.
    -AT mines
    2230 mines required / 102 mines per truck = 21.86 truckloads.
    -APF mines
    3404 mines required / 444 mines per truck = 7.6 truckloads.
    -APB mines
    4460 mines required / 10,170 mines per truck = 0.43 truckload.
  - Determined total truckloads required.
    21.8 (AT) + 7.6 (APF) = .43 (APB) = 29.83 (round up) = 30 truckloads.

Engineer Problem/Solution submitted by CPT Joseph Weihs and SFC David Thomas, both currently assigned to Mine Warfare Branch, Department of Military Engineering, U.S. Army Engineer School, Fort Belvoir, VA.

LESSONS LEARNED

The following excerpts are from a lessons learned file maintained in an automated data base by the Directorate of Evaluation and Standardization, U.S. Army Engineer School.

Survivability

Concealment

ISSUE: Poor use of existing terrain features to aid in concealment.

REMARKS: Some units were observed making poor use of existing terrain features for concealment. Vehicles were parked in the open, leaving them susceptible to observation from the air or ground. The most obvious disregard for concealment was an engineer M113, parked 10 meters from a wadi that offered excellent concealment. Disregarding the tactical environment, soldiers sat on top of the vehicle eating their rations.

SOLUTION: Commanders must stress the importance of concealment and teach their soldiers how to employ camouflage. Leaders must enforce tactical discipline and ensure soldiers do not choose convenience and comfort over concealment. In addition to man-made camouflage materials, soldiers should use natural resources such as mud, vegetation, and rock effectively to blend in with the surroundings. Be innovative.

Survivability positions

ISSUE: Quality control during construction of survivability positions.

REMARKS: During an exercise at the National Training Center (NTC), an engineer unit took 4 hours to excavate an M1 tank position which should have taken 1 hour. When completed, the position was too deep and the M1 had to come out of the position to fire. The problem had two causes. First, the position was located on the reverse side of a hill, even though it was dug in accordance with (IAW) specifications in FM 5-103, *Survivability*. Second, the M1 tank was not driven into the position at various stages of excavation to check for proper construction.

SOLUTION: If the vehicle is unavailable, stretch a string from the crest of the hill, place a line level on it, and measure the depth from the artificial horizon with a plumb bob.

Equipment operators should develop some doctrinally sound "rules of thumb" to assist them in digging positions. These may include height of blade, width of blade, depth marker bands, or line-of-sight positions on their equipment equal to those of the tank. Stress combined arms training at the home station.

Mobility

Breaching obstacles

ISSUE: Lack of coordination and effective planning when breaching obstacles.

REMARKS: The task force engineer was not involved in the tactical planning of various missions. The maneuver force was unable, consequently, to coordinate breaching operations or use the engineer units effectively. Therefore, when the missions occurred, breaching was ineffective and not according to doctrine. In one case, an obstacle could have been bypassed easily but was not. Due to lack of coordination, the engineers and the maneuver units did not rehearse together. The individual company teams and the engineers each conducted their own rehearsals.

The task force engineer was involved in planning and briefing the company teams for the last mission observed. On this mission, the obstacles encountered were breached effectively, which greatly improved the task forces' ability to continue the attack.

SOLUTION: Stress the effective use of the task force engineer to the maneuver commanders and to the engineers themselves. Ensure staff coordination so that breaching is integrated into the tactical plan. Use rehearsals, and integrate the engineers and maneuver units to ensure successful obstacle breaching and continuation of the attack.

Countermobility

Mine resupply

ISSUE: Mine Transport and Fuzing Operations.

REMARKS: The soldiers in an NTC rotation unit transported mines unrealistically. Mines were thrown into the back of a truck, sometimes to the point of overflowing. The number of vehicles required to haul live mines would easily have doubled. Fuzing operations for row minefields were completely ignored. It would take one platoon fuzing to support the company's two remaining platoons laying mines. Also there was confusion about how and where the operation should take place.

SOLUTION: Leaders must enforce realistic mine training. Until training mines are the actual size and weight of live mines, soldiers will fill vehicles beyond their mine carrying capacity. Also, some soldiers will carry several plastic or wooden "mines"—far beyond their limit if the training munitions were real.

Note: NTC is now using sand-filled M20 and M21 mines. The M20 weighs 28 pounds, which should stop unrealistic mine handling.

The best way to transport a mine is in a mine rack. Place the mines in the rack after they are uncrated and fuzed. Mine racks for M15 mines are in use by some NATO armies, and the mine rack is part of the M57 Minelayer kit. The rack has the following nomenclature and NATO stock number: Case, Carrying Mine, NATO stock number 655-21-872-4282.

Obstacles in the tactical plan

ISSUE: Obstacles were not coordinated and tied into the tactical plan.

REMARKS: Engineers prepared a formidable series of obstacles to support the task force defense. The obstacles were installed in depth. They consisted of wire obstacles, numerous linear minefields ranging from three to six rows deep, and a 700-meter tank ditch. None of the obstacles were covered by direct fire antitank weapons. Some of the obstacles were not observed, and indirect fire could not be used to support them. An underlying factor adding to this problem was the lack of an integrated (synchronized) plan incorporating maneuver, fire, and terrain.

SOLUTION: Obstacles should be covered by observed direct and/or indirect fire to destroy enemy forces that encounter them. Task force engineers must ensure the obstacle plan supports the tactical plan. This requires thorough coordination with all staff members and company team commanders.

Command and Control

Engineer support in the fire support base (FSB)

ISSUE: Prioritized engineer support is needed for the FSB and brigade support area (BSA).

REMARKS: The FSB and BSA had no command bunkers, sleeping shelters, or large artillery or mortar-proofed shelters. Heavy engineer equipment sat idle instead of being used to construct or emplace these survivability positions. When the equipment was used, it was for an antitank ditch. Not enough engineer manpower was available to construct the shelters.

SOLUTION: The FSB and BSA should receive prioritized engineer support in the form of heavy equipment. Due to limited engineer resources, engineer commanders should train FSB and BSA personnel to construct simple, less equipment intensive positions using their own resources and FM 5-103, *Survivability*. Also, non-engineers can be trained to emplace minefields and wire obstacles.

Task organization of the engineer assets

ISSUE: Task organization of engineer assets was inappropriate.

REMARKS: Engineer assets were task organized into the three company teams: two engineer squads were tasked to company teams, and one company team received an engineer squad. This organization put the platoon leaders and company commander out of work. When the task force had a defensive mission, bulldozers were issued piecemeal. Two teams received one bulldozer each and the other team received two.

SOLUTION: Do not task organize engineer assets below the platoon level. Task organization to the company level is preferred. This provides better command and control of the engineer effort and the unit integrity needed for the health, welfare, and morale of the engineer company.

Brigade engineers

ISSUE: Lack of consideration by the brigade engineer for support to the deep, close, and rear battle.

REMARKS: During an exercise, the primary focus of the brigade engineer was on the close battle. During the movement to contact mission, FASCAM was used in the brigade's deep battle. Initially, the rear battle was not addressed or resourced at all. Later, two bulldozers were provided to assist in constructing survivability positions. This effort was not coordinated or controlled. The FSB S-3 did not know that the engineer assets were available for almost 24 hours.

SOLUTION: The brigade engineer must be involved in staff planning. The brigade engineer must understand the commander's intent for fighting the deep, close, and rear battle. The expertise of the brigade engineer is needed to provide the assets required to conduct the operation. The brigade engineer must think in terms of the deep, close, and rear battle at all times during planning and execution. The focus should be on all aspects of the battle, not just one.

Training

Demolition techniques

ISSUE: Demolition Instruction.

REMARKS: Soldiers performed demolition missions while in their MOPP suits. They were unable to tie knots or tape blasting caps while wearing the protective gloves.

SOLUTION: Include MOPP IV techniques in the demolition instruction. The instructions are similar to those used for cold weather operations. Prepare as much as possible in rear areas. For example, pre-cut timed fuses and detonate cord and prepare branch lines in the rear to reduce time and effort spent on site.

Note: FM 5-25, *Explosives and Demolitions*, is currently under revision. The revised manual will include information on cold weather techniques. The revised FM 5-25 is scheduled for printing in January 1990.

Miscellaneous

Maintenance

621B SCRAPER

ISSUE: Preventive maintenance on the 621B scraper.

REMARKS: The 621B scraper is great when it comes to moving dirt. To keep it operating properly requires regular preventative maintenance.

SOLUTION: Check tire pressure before operating the scraper. The front tires require 60 PSI, and rear tires require 40 PSI. Grease the brake camshafts during the 500-hour or 3-month service. Wet or dusty conditions may warrant more frequent servicing. If you neglect them, the shafts will bind—usually when the brakes are engaged. Check the batteries during the weekly PMCS, and look for dust. Blow out dirt and dust before it packs in.

Leadership

Troop leading procedures

ISSUE: Resource management.

REMARKS: Personnel and time are two of our most important resources. Squandering either of them may result in serious consequences. A unit recently found this to be true.

Leaders took too much time preparing plans and orders, and they did not allow enough time for the squads to prepare. The warning orders gave the time and location for the upcoming mission orders. However, as the plan was made, the leaders had to push back the time for issuing the order. As a result, the squads had difficulty doing any of their own planning and troop leading.

Engineer platoon leaders were reluctant to use their NCOs and tried to do everything themselves. After three days, the platoon leaders became ineffective and were ordered to get some sleep.

SOLUTION: Commanders must convince their subordinate leaders that personnel and time are critical resources. Issue warning orders IAW the 1/3 - 2/3 rule to ensure personnel have sufficient time to prepare for the mission.

Platoon leaders must learn to train and manage their personnel. If the platoon leader is wounded or killed, the platoon sergeant must be able to assume those duties and responsibilities. Therefore, the platoon sergeant and platoon leader should work as a team during peacetime so that either can carry on for the other.

Construction

Dirkou airfield rehabilitation project

ISSUE: The construction of Dirkou airfield.

REMARKS: The Dirkou airfield rehabilitation was the first military-civic action (MCA) project ever undertaken on the African Continent. Although scheduled for two months, construction took 16 months. The final product was a 1605 meter long, 25.6 meter wide, C-130 capable runway with a parking area and taxiway, all covered with bituminous surface. Insufficient time was allocated for on-site, in-country reconnaissance and study. Thus, several key points were missed. The most damaging one involved the determination that ample rock was available close to the airfield. This one, inaccurate, finding was the basis for an optimistic construction schedule and false expectations of an early completion.

SOLUTION: The in-country study should have been used as the first step in the process of developing project plans and specifications. Then, step two should have refined the information leading to the last step, the development of the final project documents. Instead, the initial (incorrect) finding, that sufficient quantity of rock was available near the airfield, was used to determine project duration. Adding to the delay was the omission of several critical items of equipment, including a crusher dolly, rotary broom, rock bucket, and asphalt kettle. An underlying theme to be remembered is: do not underestimate the realities of working in third world environments.

Dirkou airfield rehabilitation project

ISSUE: Lack of quarry and asphalt skilled personnel.

REMARKS: Over the past 10 years, the number of personnel skilled in quarry and asphalt operations has decreased due to budget cuts and manpower caps. The requirements for personnel skilled in these areas may not be needed in many environments. However, it was evident during the Dirkou, Nigeria, airfield construction project that these skills sometimes are critical. In the third world's austere environment, it will be difficult for engineers to support peacetime operations similar to the Dirkou airfield construction because of the limited number of skilled soldiers available.

Lessons learned Afghanistan

Antitank mine

ISSUE: Preventing detection of the antitank mine.

REMARKS: The Mujahedeen, in the Afghanistan war, prevented mine detection by removing the bottom of the antitank mine and burying the mine upside down. This helped prevent detection during probing because the probe normally penetrated the soft explosive compound. If the prober detected the mine, the Mujahedeen could command detonate it with supplemental explosives placed around the mine. In addition, the Mujahedeen dug a cone-shaped cavity under antitank mines to cause a delay in detonation. Vehicles rolling over the mine would push it deeper into the ground until the mine reached the bottom of the hole. The next vehicle rolling over it would detonate the mine. This destroyed a vehicle somewhere in the middle of the march column and reduced the confidence and morale of soldiers throughout the convoy.

Decoy minefields

ISSUE: Using decoy minefields to slow down a convoy.

REMARKS: The Mujahedeen used pieces of scrap metal to confuse mine detector operators. They also buried small pieces of explosives to alert bomb dogs. Clearing these decoys took nearly as long as clearing a real minefield. One or two real mines were always buried with the decoys to enhance the obstacle's effectiveness.

Mine concealment

ISSUE: Concealing mines.

REMARKS: To conceal their mines, the Mujahedeen soldiers rolled tires over buried mines to indicate, deceptively, that vehicles had safely passed over the area. They also placed large stones on top of the mines. Because of the great number of stones in the area, engineers probing for mines would constantly hit stones and become lulled into a false sense of security. Thus, they missed mines buried under some of the stones.

Responding to Change

by Dr. Martin Reuss

Historically, the Corps of Engineers has been a reactive and responsive organization. With generally great success, its leaders have executed the missions tasked by Congress, the Secretary of the Army, and, in the end, the American people. When general agreement existed about what the goals and hopes of the nation were, it was relatively easy to define agency priorities. When the consensus disintegrated, the agency's ability to respond to numerous and sometimes conflicting guidance became the key to success and even survival. Flexibility has always been necessary and new missions often led to improved solutions. It is probably true that the management on occasion was jerry-rigged. Still, the Corps got the job done.

When the Corps was given the responsibility to survey roads and canals in 1824, it lacked sufficient manpower and used civilian assistants and officers from other Army branches. After the Civil War, when Congress drastically increased the rivers and harbors work given the Corps, the Chief of Engineers, Brigadier General Andrew Humphreys, organized boards of senior officers who traveled around the country reviewing both rivers and harbors and fortifications work done under the supervision of junior officers. At any one time these officers supervised an average of 20 projects that were, according to Humphreys, "scattered in almost every case, over hundreds of miles of territory...taxing the physical and mental abilities of these officers to a degree embarrassing to the service."

In 1941, when the Corps became responsible for military construction, it leaned on the civilian workforce, until then experienced mainly in civil works, to accomplish the new mission. Even then, had not some civil works projects been delayed to save money due to the war efforts, the Corps' resources would certainly have been stretched to the breaking point.

The 20th century has certainly tested the Corps' flexibility. The organizational strength and responsibilities have increased tremendously, but the growth has not been painless. The environmental era produced doubts about massive water projects. In the early 1980s, concerns about the ability of the federal government to finance large projects portended substantial reductions in the Corps' civil works program. However, legislature passed in 1986 laid the groundwork for a new federal-nonfederal cooperative effort to finance needed projects. Meanwhile, combat engineers have had to adapt to a battle environment considerably different than what existed a generation ago. Mobility, firepower, and adequate logistics support, always important, have become even more so in today's Army. Even the public regard for the engineer has changed. At the beginning of the century engineers were considered national heroes, people who would quite literally erect a better world. In the aftermath of the atomic bomb, massive pollution problems, and growing doubts about some large-scale projects, engineers tend to be regarded more equivocally.

Engineering values have changed just as the nation's have. "We were planning a work for the nation," wrote engineer officers in their 1826 report on the Chesapeake and Ohio Canal, and "it did not belong to us to curtail the cost in order to derive from the capital a greater interest... to the detriment of durability and conveyancy." In the 19th century, the Corps of Engineers thought in terms of grand works of improvement that would help knit the nation together, promoting both political stability and commercial development. Army engineers working on plans to circumvent Muscle Shoals in 1828 wrote of a fiscal responsibility "higher than money". Today, except for assuring adherence to minimum safety factors, which often are legally prescribed, engineers are always expected to tailor their designs to accommodate financial and political realities. Only in wartime do safety, economy, and durability give way to speed and expediency.

Chiefs of Engineers seldom had much time to think about social and economic changes that might affect the Corps' future. Immediate tasks needed to be accomplished, often with insufficient funding and personnel, which precluded attention to more distant problems. However, the changes that the nation has been undergoing in the economic, geopolitical, military, and environmental areas are forcing the Corps, and the entire Army, to step back and attempt to prepare for the next century. At the same time, we dare not forget the lessons that can be learned from studying our past.

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Promoting Self-development

by Rita Price

Are you a "have" or a "have not?" This may not make sense to you, but let me explain. A "have" is a person who decides that schooling is important and seeks opportunities to get an education. As you may have guessed, a "have not" is someone who decides, for various reasons, that school is a real drag. At best it is boring, tedious, and certainly something to be avoided. I want to tell you about some rather painless ways to get ahead of the education game. If this sparks your interest, read on.

It is my contention that we in the military are not living up to our full potential in assisting soldiers who have difficulty meeting civilian education goals. You may recognize the type: The soldier who talks about going to school but has a million reasons why he can't attend. Promotion boards use civilian education as a discriminator for advancement, but even that may not be enough to get these soldiers to enroll. The "have not's" are torn between doing what they feel they should and feelings or beliefs that they simply can't attend school.

Some soldiers may not know that Army education centers, staffed with trained counselors, have information that can benefit anyone who wants to obtain schooling. These centers are on most military installations and offer a full range of information on schooling, from prehigh school to masters levels.

Many education options are available. For example, did you know that a bachelors degree can be earned without setting foot in a conventional classroom? This is possible through the New York Regents' Degree Program, a fully accredited, nontraditional degree-granting institution. Their staff evaluates a student's portfolio, which lists all experiential life credits plus any previous course work, and then determines what courses need to be completed. The student is awarded a degree after the required credits are completed. Job experiences are an example of experiential life credits—what you've been doing on the job plus other relevant work. It may be possible to complete all required work with testing and such nontraditional means as classroom satellite videos.

The point is, many military members may not know they have experiences that can qualify for college credits. It may serve as an incentive to the "have not's" if they knew some college credits were already under their belt.

Education centers have many testing instruments, such as interest inventories and aptitude tests, to help soldiers develop an education strategy. There is no cost to the soldier for these services. In addition, counselors will assist individuals grappling with such problems as where to start, how to study, or how get back into the swing of things.

College correspondence courses are available. However, these courses require a student's dedication and motivation to successfully complete the work. For returning students, the lack of a traditional classroom instructor and the lack of interaction with other students may be stumbling blocks. There is no support group to offer encouragement if the going gets rough.

These are a few of the opportunities available to military personnel.

If you identify with the "have not's" and want to return to school, I suggest first taking a course just for enjoyment. Try something that's not involved with the three R's. Enroll in an auto mechanic or painting course, perhaps one related to a hobby. A "fun" course can get a soldier back in the mainstream of the school routine. It may eliminate some anxieties associated with taking more traditional courses.

The object is to get back into the swing of attending courses and to start interacting with other students. Make the initial going back to school experience enjoyable and concentrate on taking one mole hill at a time. You need not climb the whole mountain at once.

The Army wants to develop success-oriented soldiers, people with high self-esteem who remain viable for promotions. Army leaders must take an active role in assisting soldiers who experience "heart burn" when attending civilian schools. Many Army leaders do this now, others do not. This might include having a counselor come to your section to discuss opportunities at the education center, or stressing the importance of educational credits to everyone in your unit.

Soldiers who find education a distasteful and stressful experience, and who avoid attending classes, may miss some important gates in their careers. Leadership at all levels must make a conscious effort to assist subordinates who may be experiencing education hurdles. They must support all attempts at improving their subordinates' education levels and encourage self-development. After all, don't we all want to be a "have?"

Rita Price is the Deputy Chief, Engineer Personnel Proponent Office at Fort Leonard Wood. She is a Ph.D. candidate in higher education and is a major in the Missouri Army National Guard.

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About the cover

The spirit and heritage of the new Engineer Regiment is exemplified by the gathering of unit flags at the 1989 Engineer Commanders' Conference at Fort Leonard Wood.

Photo by LTC George Woodbury

Special thanks to TASC personnel for their support.

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CLEAR THE WAY

by MG Daniel R. Schroeder
Commandant, U.S. Army Engineer School

> *"Resolved, that the engineers in the service of the United States shall be formed into a corps, and styled in the 'Corps of Engineers;' and shall take rank and enjoy the same rights, and privileges with the other troops on continental establishment."*
>
> Continental Congress
> March 11, 1779
> (Ford Journals of the Continental Congress, 13:305-06)

As we continue to modernize and evolve the AirLand Battle-Future (ALB-F) concept, we should pause to reflect on our heritage as engineers. The formation of our regiment is the focus of this issue of the ENGINEER Professional Bulletin. The colors of the Engineer Regiment pictured on the cover represent the historic lineage of the Corps of Engineers.

Our regiment originated on June 16, 1775 when the Continental Congress authorized a Chief Engineer and two assistants for the fledgling Continental Army. Predating the Declaration of Independence, the regiment became instrumental in the success of the nation in both war and peace.

With 214 years of rich heritage, an Engineer Regimental Association was needed to foster the traditions of our corps. This year, with the move of the Engineer School, the Regimental Association established its headquarters at Fort Leonard Wood.

The purpose of the association is to promote the Corps of Engineers Regiment, with special attention to the role of the Army engineer in ground warfare. It will foster and preserve the history, traditions, and solidarity of Army engineers. The association will sponsor a professional recognition program, offer academic scholarships, and serve as an authoritative source of historical information.

The association is a nonprofit organization. Its members are serving or retired personnel from any component of the Army, cadets of military schools and ROTC programs, and civilians who subscribe to the purposes of the association.

The Regimental Association kicked into high gear during the Engineer Commanders' Conference and first annual Regimental Dinner, held at Fort Leonard Wood on May 5-7. Conference highlights included addresses by John O. Marsh, Jr., Secretary of the Army, GEN Carl E. Vuono, Army Chief of Staff, and MG Michael Spigelmire, Commandant of the Infantry School. The challenges for Army engineers presented by GEN Vuono are described in this issue beginning on page 8. Infantry's contributions to the AirLand Battlefield are explained by MG Spigelmire (page 12).

John O. Marsh, Jr., received the Regimental Association's inaugural gold de Fleury Medal at the conference. This medal will be presented annually to an individual who exemplifies boldness, courage, and commitment to a strong national defense. The medal traces its origins to October 1, 1779. The Congress of the United States recognized and created the medal for Captain Francois de Fleury, a French engineer, for his heroic actions during the recapture of Stony Point, New York, on July 15, 1779.

In addition to the gold de Fleury medal, the Regimental Association also awards silver and bronze medals. Award of the silver is approved by the Chief of Engineers after nomination through the Commandant, U.S. Army Engineer School. The silver order may be awarded to one who has rendered outstanding service to, or support of, the regiment. The bronze must be approved by a member of the regiment in the grade of colonel currently in command, a commander of a divisional engineer battalion, or a lieutenant colonel district commander. It may be given to members or nonmembers of the regiment (military or civilian) who have rendered significant service to or support of an element of the regiment.

For additional information about the association or awards, contact COL John M. Morgan, President, Engineer Regimental Association, P.O. Box 634, Fort Leonard Wood, Missouri 65473.

The Regimental Dinner is now the forum for presenting the SAME-sponsored Sturgis and Itschner Awards. The Sturgis Medal is presented annually to an active duty enlisted soldier for outstanding contributions to military troop construction and/or base maintenance through demonstrated technical and leadership ability. This year's recipient was Staff Sergeant Paul D. Weber, Company A, 79th Engineer Battalion (Heavy).

The Itschner Award, named for Lieutenant General Emerson C. Itschner, the 39th Chief of Engineers, is presented to the most outstanding engineer company of the Active Army, Army Reserve, and Army National Guard. Lieutenant General Itschner and Lieutenant General Henry J. Hatch, the Chief of Engineers, presented this year's awards to Company A, 65th

BRIDGE THE GAP

by CSM Rudolf F. Voigt, Command Sergeant Major (Ret.), U.S. Army Corps of Engineers

Noncommissioned officers (NCOs) have contributed immensely to the Corps of Engineers and the U.S. Army over the past 214 years. I felt pleasure and pride when the Army leadership announced the 1989 Army theme, "The Year of the NCO."

It is unfortunate that historians have captured little of the NCO corps over the last two centuries. Little or nothing is written about the engineer NCO, as indicated by Arnold Fisch, Jr., in his draft paper titled "Backbone of the Army: A History of the Noncommissioned Officer Corps." Mr. Fisch mentions many branches of the Army in his paper, but includes nothing about the Corps of Engineers. However, the sacrifices and hardships endured by the "Backbone" of the Army have not been in vain. Their contributions have been recognized from the beginning, in 1779 by Baron Von Steuben, and by many great leaders since then.

NCOs have played a vital role in the U.S. Army Corps of Engineers (USACE). They have always been the cornerstone for construction and combat engineering, allowing officers to do the planning while they accomplished any given task with engineer soldiers. World War II, often called the "Engineer War," and Vietnam saw more engineers on the battlefield than soldiers from any other single branch.

NCOs in USACE often have been called upon to perform as platoon leaders. They do a commendable job in this role and then fade back into the ranks when an officer takes command again. The performers, the technical and tactical experts in the field, have always been the NCOs in the Corps of Engineers. Our NCOs learned their jobs on the ground, often by trial and error. But, they learned and then did them right thereafter. Our NCOs have been instrumental in all military construction and in every active U.S. Army theater in the world. Today our NCOs are active in every MACOM, no matter where the location.

We have some unique groups of NCOs in USACE. Construction inspectors perform their vital quality assurance work at many remote locations throughout the world. They oversee multimillion-dollar projects and ensure quality construction for the Army and others. Power generation specialists maintain nontactical power plants and support the DEHs around the globe. They provide power to major headquarters during exercises in the Middle and Far East and in Central and South America. They also provide backup power to many friendly nations in the Caribbean and Pacific. Our dedicated personnel NCOs maintain military records and provide an important link between the civilian workforce and the military personnel system. Logistics, maintenance, and law enforcement NCOs, and intelligence and cartographic specialists, provide outstanding support functions to the Corps of Engineers.

Our NCOs are not Beetle Bailey characters but well educated professionals. Many have college degrees related to their specialties. Today's NCOs are leaders, trainers, and role models who contribute immensely to the success of the Army.

CSM Rudolf F. Voigt was Command Sergeant Major, USACE, from 1984 until his retirement in June 1989. During his 33 years of service, CSM Voigt served in every leadership position in the NCO Corps.

Clear the Way (continued)

Engineer Battalion (Active Army); Company C, 391st Engineer Battalion (C) (Army Reserve); and the 200th Engineer Company (Assault Float Bridge), 137th Engineer Battalion (Army National Guard).

Visitors and initial entry training soldiers at Fort Leonard Wood will get a dose of regimental history. Training areas (TA) and facilities are being renamed for battles and campaigns. For example, TA 250, the Float Bridge Training Area, will become the Remagen Training Area. During instruction at each site, students will receive a brief history presentation concerning the regiment's involvement in the action for which it was named. The intent is to heighten warfighting focus and develop pride in new and old soldiers.

The Engineer Regiment has received new life. The Regimental Association is off to a good start, but we need the help of all Army engineers and their friends to make it a viable organization. By pulling together, we can make it a dynamic, useful, and proud organization that serves our soldiers, our units, and the Army. The history of our regiment and this great nation are woven together in peace and war. We must preserve our history and instruct an awareness of it.

–SCHOOL NEWS–

Directorate of Training and Doctrine (DOTD)

Safety Flash! All 12F soldiers will learn how to prepare an M9 ACE for swimming while going through AIT at Fort Leonard Wood, Missouri. However, no M9 ACE swimming will take place until a training facility can be established for this task. We recommend that *no* M9 ACEs be used in water until personnel have received adequate training.

ARNG/USAR Engineer Update. The Reserve Component Engineer Refresher Course Catalog for FY 1990 is scheduled for distribution in July 1989. Courses offered for the period October through December 1989 will be conducted at Fort Belvoir, and those offered from January to May 1990 will be conducted at Fort Leonard Wood. For additional information, contact Cathy Holland at AV 581-4263 or (314) 368-4263.

Phase 1 of EOAC, the Company Command Module, will be held at Fort Leonard Wood from November through December 1989. Engineer School resident instructors will present the training.

Active Guard/Reserve link-senior RC advisors to the Engineer School and Center are:

Fort Belvoir–COL Joseph Shoff (USAR), AV 354-4434 or (703) 664-4434.

Fort Leonard Wood–COL Lloyd Vienneau (USAR), AV 581-3181 or (314) 368-3181; and LTC Charles Doll (ARNG), AV 581-1174 or (314) 368-1174.

Engineer Hotline. Need an answer to an engineering question to complete your mission, finish coursework, or just settle an argument? Call the Engineer Hotline, now located at Fort Leonard Wood, and get a timely response from the experts at the Engineer Center and School. Call AV 581-3365.

Engineer ARTEP Mission Training Plans. Mission Training Plans (MTPs) form the basis for a highly trained, combat ready engineer force. These "how to fight" publications exemplify our continuing effort to enhance engineer training in the combined arms context.

ARTEPs 5-145-MTP, 5-145-11-MTP, and 5-145-31-MTP, dated 17 February 1989, are now available. These books cover the following units: HHC, Engineer Combat Battalion, Heavy Division, TOE 5-145L; HHC, Engineer Battalion, (Combat) (Corps), TOE 5-35H; HHC, Engineer Battalion, (Combat) (Corps) (Mech), TOE 5-45H; HHC, Engineer Combat Battalion, Infantry Division, (National Guard), TOE 5-155H, HHC Engineer Combat Battalion, Heavy/Light Infantry Division (2ID), TOE 5-165L; and the following companies and their platoons: Engineer Company, Engineer Combat Battalion, Heavy Division, TOE 5-145L; Engineer Company, Engineer Battalion, (Combat) (Corps), TOE 5-35H; Engineer Company, Engineer Battalion, (Combat) (Corps) (Mech), TOE 5-45H; Engineer Company, Engineer Combat Battalion, Infantry Division, (National Guard), TOE 5-155H; Engineer Company, Engineer Combat Battalion, Heavy/Light Infantry Division, (2ID), TOE 5-165L; Engineer Company, Heavy Separate Brigade, TOE 5-143L; Engineer Company Armored Cavalry Regiment, TOE 5-108H.

These ARTEPS will assist in Mission Essential Task List (METL) development and execution of FM 25-100 (see this issue of ENGINEER, page 15). Their value in strengthening the engineer's role in battle cannot be overemphasized.

The MTPs supersede ARTEP 5-145, dated 29 December 1980, but they do not supersede ARTEP 5-35 entirely. ARTEP 5-35 addresses the engineer combat support equipment company (CSE) and its platoons. The CSE company and platoons will be covered in the ARTEP 5-415 series MTPs, which are scheduled for fielding in 1990. Until then, CSE units should continue to use the ARTEP 5-35. POC is CPT Long or Russ Hinkle, AV 581-7456 or (314) 368- 7456.

—SCHOOL NEWS—

Directorate of Military Engineering (DME)

Engineer Officer Advance course (EOAC). The EOAC Division of DME will be closed starting 4 December 1989 during the move to Fort Leonard Wood from Fort Belvoir. Instruction will resume with class 1-90 on 29 January 1990. Six classes are scheduled for FY 1990. In conjunction with the move, the number of team leader positions will be expanded to twenty. POC for the transition of EOAC is LTC Bohn, AV 354-4539 or (314) 368-4539.

Warning: Transport of Primed Charges Prohibited. Observations at NTC and JRTC have shown that units are transporting charges or firing systems primed with blasting caps. This practice violates demolition safety procedures and is prohibited. Attach blasting caps to charges or firing systems only immediately before detonation.

We recommend using detonating cord to preprime charges because most charges primed in this manner can be transported safely. For example, it is acceptable to transport a bangalore that is primed with eight wraps of detonating cord. Two initiation systems that contain the blasting caps can be attached to the running end of the detonation cord when the bangalore is positioned at the blasting site.

"Pop and Drop" Minefield Breaching Technique. Field observations indicate many units use the pop and drop method as their primary mine reduction technique when creating assault lanes in minefields. We recommend the pop and drop method be used only as a last resort because it is more dangerous to soldiers than the equally successful line main method.

The pop and drop method is unique in that the blocks of explosives are individually preprimed with blasting caps and fixed links of time fuse. When a soldier finds a mine during a breach, he lights the time fuse (pop) and sets the charge next to it (drop). Although any manual breach is inherently dangerous, this procedure creates unnecessary risks:

- It is obviously dangerous to carry demolitions primed with blasting caps.
- The detonation of one individually primed charge may displace a charge placed next to another mine.
- Individually primed charges are subject to misfire, creating a hazard and potential time delay that could jeopardize the mission.
- Once a charge is initiated, the soldier in the minefield has no choice but to continue to move, even if taken under fire.
- A soldier who becomes a casualty in the minefield after a charge in initiated, probably cannot be evacuated before the charge detonates.

The line main method avoids these risks. This method is similar to the pop and drop method, but the individual demolition charges are primed with detonation (det) cord instead of blasting caps. Like the pop and drop method, a soldier places the primed demolition next to a mine. Then he ties the det cord lead to a det cord line main, which is run the length of the lane. When the charges are ready for detonation, only the line main is primed and fired.

The line main method may be slower and require more soldiers than the pop and drop method, but with practice it can be as successful. We recommend that it be your primary mine reduction technique. POC is MAJ Ross, AV 354-6901 or (703) 664-6901.

Engineer Update

–SCHOOL NEWS–

Directorate of Combat Developments (DCD)

ESSAYONS. The ESSAYONS Program provides the U.S. Army Engineer Center with a simplified process for correcting shortcomings and deficiencies in engineer doctrine, materiel, force structure, and training. ESSAYONS is designed to solicit recommendations for concept or system changes from the engineer community. Since September 1988, ESSAYONS has received several proposals from engineer soldiers. Some of them reflect needed improvements in existing engineer systems. Not every proposal is accepted, but all are thoroughly staffed before a final decision is made. Changes begin with the soldier, and ESSAYONS is the first step to making those changes. Please send your ESSAYONS proposals to: Commandant, U.S. Army Engineer School ATTN: ATSE-CDT, Fort Leonard Wood, MO 65473-6620. POC is SFC Gay, (314) 368-2386 or AV 581-2386.

Directorate of Topographic Engineering (DTE)

Terrabase Instruction for EOAC. The Directorate of Topographic Engineering, in conjunction with the Directorate of Combined Arms, has initiated Terrabase instruction in the Engineer Officer Advanced Course. This exercise introduces students to Terrabase, a tool for terrain analysts. The training provides analysts with a way to integrate a wide variety of terrain data using a personal computer with flexible on-screen images. Hard-copy products enhance the commander's ability to make battlefield decisions.

The system can create line-of-sight profiles, which enable the user to assess weapon, radar, and radio placement. It computes cross-country maps using LANDSAT data and performs climate and weather-related tasks. The software program displays three-dimentional representations of the terrain. The TerraBase software was written at the Department of Geography and Computer Science, U.S. Military Academy. POC is CPT John Soussounis, AV 581-6266 or (314) 368-6266.

MOS 82D (Topographic Surveyor). MOS 82D will change significantly in the next several years. Some of the changes are due to AirLand Battle-Future doctrine and revised scope and duties of the MOS. Topographic surveyors will share site information collection tasks that were formerly the sole responsibility of the Terrain Analysists, MOS 81Q. The loss of the Survey Warrant Officer, MOS 215B, will bring new responsibilties to E-7 MOS holders.

The Survey Instrument Maintainer course at Defense Mapping School (DMS) is a reality. Graduates are awarded an ASI of C7. The computer literacy functional course, another DMS service, has been endorsed by the Air Force and Marine Corps. It provides instruction on the use of personal computers and standardized programs for survey computing and computer-generated drafting. TRADOC acceptance of this course will increase the productivity of topographic survey squads and address the training imbalance of the skill level 2 MOS holders.

MOS 82D Publications. Future training publications will reflect printing fund reductions. For example, literature describing the use of new equipment and systems will be produced by the respective manufacturers. Army correspondence subcourses and Technical Extension Courses will be revised, when necessary, by issuing changes to existing publications. The old stand-alone Training Manuals (TMs) will be phased out. We anticipate that they will be replaced by FM 5-232, scheduled for distribution in FY 1990; two college texts on surveying that are in the TSS Van library; and a new text, "The Surveying Handbook," edited by Brinker and Minnick. The commercial publications, if approved, will be issued to survey squads in FY 1990. The "Soldier's Manual and Trainers Guide" will be revised through a series of changes to the current edition starting in FY 1991. POC is SFC Konstan, AV 581-6266 or (314) 368-6266.

—SCHOOL NEWS—

Directorate of Engineer Branch Safety (DEBS)

Engineer Branch Safety C.A.R.E. Alert! The Engineer Branch Safety office is using a new worldwide safety alert system on an experimental basis until final approval for it is received. The system provides engineer units with immediate information about accidents and incidents where real or potential safety problems exist.

Engineer Branch Safety Issues—FY 1989. The Commandant has identified the top safety issues to be worked in FY 1989:

- Demolition Training
- Engineer Equipment Operator Safety Integration
- Fast Water Bridge and Boat Training
- Mine Warfare Training
- M9 ACE Operator and Supervisor Training

Send us your thoughts on safety issues for FY 1990. Write to: Directorate of Engineer Branch Safety, ATTN: ATZT-S, Fort Leonard Wood, MO 65473-5000. This is your chance to be heard! For more information, call Tom Moran at AV 581-7174 or (314) 368-7174.

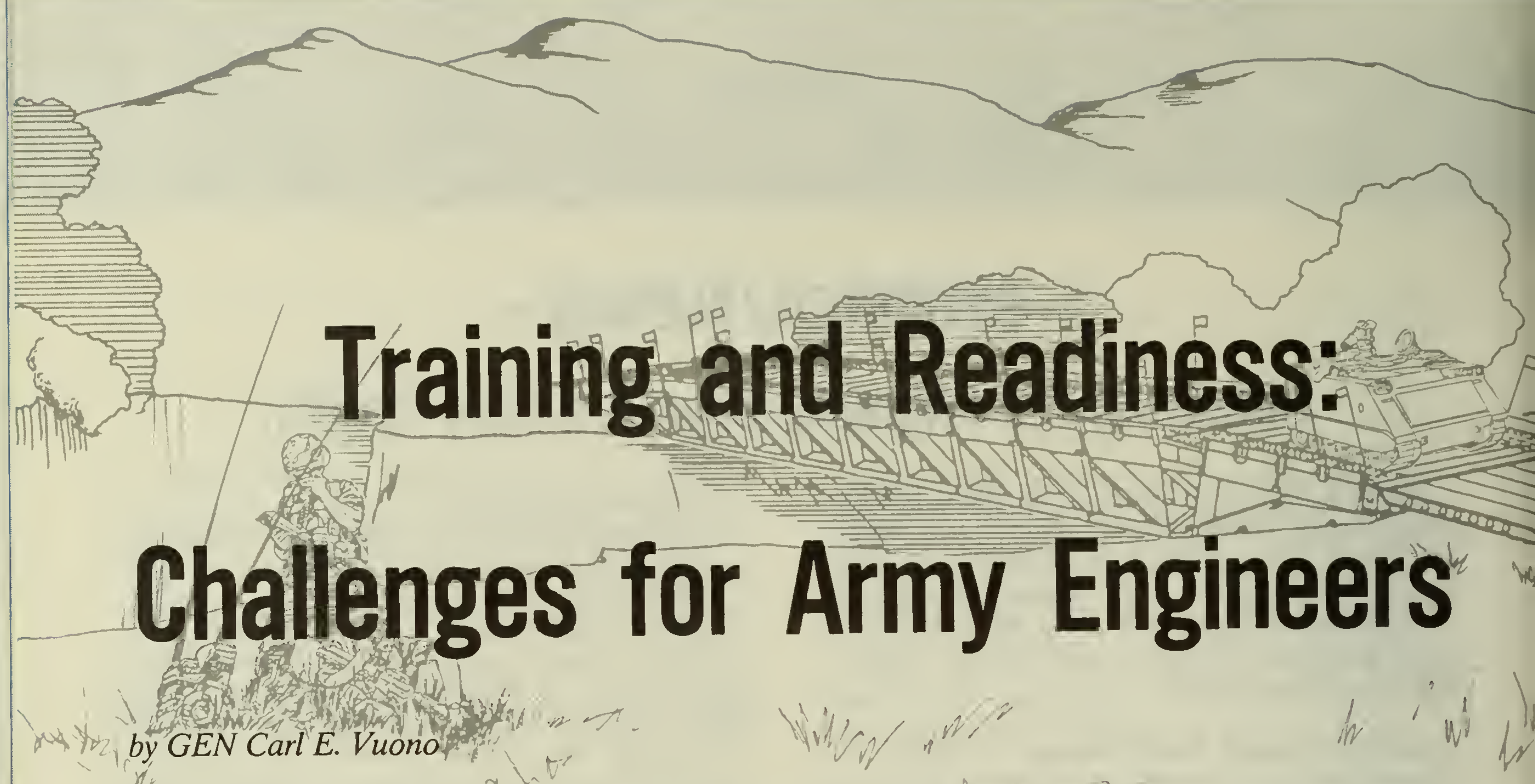
Directorate of Combined Arms (DCA)

Transition Update. DCA will continue to teach tactics to the officer basic and advanced courses at Fort Belvoir until December 1989. Classes will resume at Fort Leonard Wood in January 1990. We continue to update our instruction methods. Terrabase, a computer-based terrain analysis system, is used for terrain analysis instruction. Commercial video tapes, produced by Chris Donnelly for Janes, are being used for training on Soviet tactics and operations. We also are developing a river crossing interactive video disk and are converting all terrain exercises to Fort Leonard Wood's terrain. Special texts recently published include: *The FASCAM Handbook, E-Force Combat Operations, Engineer Standard Command Posts, Tactical Tasks—A Primer for Captains, Engineer Planning in the Combined Arms Team, Survivability of the Company Battle Position,* and *How to Defend with an Engineer Platoon.* If you need a copy, write to: USAES, ATTN: ATSE-BCA-T, Fort Belvoir, VA 22060-5341.

—REGIMENTAL NEWS—

Engineer Regimental Association Activities. Recent initiatives will increase the Engineer Regiment's visibility within the Corps of Engineers. The Chief of Military History is preparing an inventory and identifying the colors of inactivated engineer regiments, currently held by the Institute of Heraldry. Our intent is to assume responsibility for these colors and display them in the Hall of the Regiment at Lincoln Hall (the new schoolhouse) and at important regimental functions.

Beginning in July, a regimental affiliation certificate and color print of the engineer regimental crest will be presented to newly graduated corps members. These awards will be presented at or just before the graduation ceremonies for newly commissioned officers, warrant officers, and advanced individual training graduates. Certificates for personnel presently on active duty will be available to those who request them. For additional information, call the Engineer Personnel Proponent Office, AV 581-2266 or (314) 386-2266.



Training and Readiness: Challenges for Army Engineers

by GEN Carl E. Vuono

Throughout its proud history, the Army Corps of Engineers has stayed trained and ready in peace to perform demanding wartime combat engineer missions. In preparing for those missions, engineer leaders have used ingenuity and innovation to develop a greater battlefield capability and to ensure that all members of the combined arms team are at the right place, at the right time, with the right amount of combat power. Engineers have complemented readiness for combat engineer missions with operational experience in military construction and civil works. In performing these complementary missions, the Corps of Engineers has become an indispensable member of the combined arms team. It has contributed to a warfighting capability that our potential adversaries understand and respect. In the process, engineers have assisted in driving the evolution of our Army—its doctrine, organization, materiel, training, and development of leaders—as we strive to achieve our vision in the years ahead.

My Vision: A Trained and Ready Strategic Force

My vision is to have a trained and ready Army, today and tomorrow, that is capable of carrying out its strategic role anywhere, anytime. I envision our Army as a strategic force because it is vital to America's security and is essential to our national military strategy in both peace and war. The Army accomplishes roles that *only the Army* can perform. Only the Army can defend U.S. vital interests in sustained land combat wherever those interests are threatened. Only the Army has the elements of combat power and support able to conduct contingency operations or support friendly nations' land forces around the globe. Only the Army has the active and reserve forces needed to support our civil authorities in many types of disasters and crises. Most important, to our nation and our allies, only the Army can provide that most visible and credible symbol of national resolve—the soldier deployed on freedom's frontier.

In all of these strategic force roles, the Army Corps of Engineers is an integral and indispensable element of our combat power. Army engineers are among the first to deploy in contingencies, as they did in Grenada in 1983. Engineers support friendly land forces in civic actions, such as National Guard and Army Reserve engineer units building roads in Honduras. Finally, engineer units, forward deployed in Korea, Europe, and Panama, send a message of unmistakable American commitment to the defense of peace and freedom by our nation's premier strategic force.

Maintaining a Trained and Ready Army

As a strategic force, the Army must be prepared for an instantaneous transition from peace to war. Our Army is trained and ready to make that transition should we ever be called upon to do so. Staying a trained and ready Army in the future demands a carefully crafted mix of readiness, modernization, and force structure in a way that minimizes risks for America. It requires that we provide demanding and challenging training of soldiers, units, and leaders to maintain the capabilities we need to meet our strategic roles.

The foremost priority for our trained and ready Army is to continue recruiting and retaining quality men and women for our ranks. Quality soldiers enhance our capabilities and give discipline to the force. Increased capabilities and discipline give us the flexibility necessary to respond successfully to

the wide variety of crises, conflict situations, and peacekeeping requirements that continually develop.

Quality at all levels encourages improved performance on difficult tasks. This is an important factor to engineers, who execute missions as small teams under the supervision of junior leaders in a wide variety of environments. The challenge, in the face of a declining manpower pool, is to retain the very best soldiers with dynamic and exciting training in units. Further, we must provide quality-of-life programs in our communities that emphasize excellence in facilities and services for these soldiers and their families.

Another priority for keeping our Army trained and ready is to know how to fight with a doctrine that maximizes our combat capability. Today, units in our Army continually seek to achieve full combat power by synchronizing all elements of the combined arms team with a widely accepted how-to-fight doctrine, AirLand Battle.

We have several challenges in knowing how to fight. The first is to ensure that every engineer leader—officer and sergeant—knows the doctrine, particularly for mobility, countermobility, and survivability. The second challenge is to translate that doctrine into the tactics, techniques, and procedures that are essential for engineer soldiers, units, and leaders at every echelon to be successful on the battlefield. The third challenge is to provide the Engineer School constructive criticism for the refinement of tactics, techniques, and procedures. The final challenge is to continue to seek ways to improve combined arms team doctrine. In that regard, we are shaping doctrine with AirLand Battle-Future and Army 21, which are operational concepts for how we will fight in the next century. As our doctrine and technologies mature, Army engineers must meet this challenge and continue, as full-fledged members of the combined arms team, to shape the Army of the future.

A trained and ready Army must also maintain an appropriate mix of heavy, light, and special operations forces in our structure. They will provide the necessary diversity of capabilities in quality, composition, and size to meet our combat requirements and our strategic force responsibilities. We have in our Army today adequate combat and support units to defeat the wide variety of threats facing our nation across the full spectrum of conflict. We have the right combination of U.S.-based and forward-deployed forces; the proper ratio of combat, combat support, and combat service support forces, and National Guard and Army Reserve units. They are supported by a skilled civilian work force that is capable of assisting in major mobilization obligations worldwide. Engineers, a significant part of each component in that mix, perform an essential role for the combined arms team.

The first challenge to maintaining this mix is to keep a perspective of diversity throughout the Army about our organization and to remain capable of integrating all forces across the spectrum of conflict. This means finding the most efficient and responsive ways to structure forces to meet a formidable enemy on the battlefield. The second challenge is to keep the force structure appropriate for evolving doctrine. As doctrinal changes occur, revised engineer requirements will emerge. These requirements will call for us to adapt with force designs that make sense to engineers, but most importantly, will provide engineer unit designs that continue to provide support to the combined arms team in the warfighting roles.

Louisiana National Guard engineers install culvert for a road project in Panama. Such missions provide engineers with dynamic training opportunities and give high visibility to our commitment to allied nations.

Another priority for staying trained and ready is to continue to improve our combat capability by developing and fielding the most capable organizations and warfighting systems. Our approach to modernization is to ensure adequate funding for capabilities needed today while setting aside sufficient resources for research and development for capabilities needed tomorrow. Our efforts are guided by an equipment modernization strategy with functional area modernization plans. They include a comprehensive, forward-thinking approach to managing the technology base for the greatest long-term return on our resource investments. These plans address both near-term and long-term modernization.

In the near-term, we will continue acquisition of current systems that provide our highest priority units with needed capabilities now. We will also protect our investment by making product improvements on current systems to keep them effective as contributions to our combat capability. In the long-term, we will continue to field the most modern systems and replace systems that no longer are effective or capable of surviving on the battlefield. Finally, we will continue to endeavor to shape our future combat capability with research and development on new systems that will greatly add to our combat power.

The first challenge in modernization is to develop the requirements necessary to improve combat capability. This challenge involves a close relationship between combat and materiel developers in the generation of requirements. It also calls for the active involvement of combat and materiel developers in integrating our modernization efforts across all functional areas. The second challenge is to maintain a balance between the pace of equipment modernization, the development of key technologies, and fielding of systems that make the greatest contribution to our warfighting readiness. That may mean fielding in smaller numbers. We must keep a long-term perspective while improving our near-term capability. The third challenge in modernization is to keep the modernization plans current so that they uphold discipline in our drive to shape the future.

Another priority for staying trained and ready as an Army is to continue to emphasize training of soldiers, units, and leaders. Perhaps the most significant achievement during 1988, the Year of Training, was a renewed commitment to the

The 902nd Engineer Company directs M-1 tanks across a bridge they constructed during REFORGER 87. Training soldiers and units as a combined arms team, under realistic conditions, will maximize our combat capabilities.

combined arms team approach in training. I see evidence of this everywhere—in our forward-deployed and CONUS-based units, and in our service schools. I especially note this trend at the combat training centers, where synchronized combat power is reinforced to our leaders. Commanders are repeatedly convinced of the enormous value of engineer support in battle, and they continue to learn that single-capability solutions have tragic consequences. There is no place on any battlefield, in peace or in war, for an operation that does not make full use of every asset available to the commander. The training challenge is to continue providing for our soldiers, units, and leaders the tough, realistic training they expect. Our duty is to train soldiers and units as a combined arms team on the most difficult tasks, under realistic conditions, and to high standards. High training standards save lives, in peace and war. Standards for tomorrow's Army will be set by the soldiers, units, and leaders we train today.

The final priority for staying trained and ready as an Army is to remain committed to developing the most outstanding leaders the world has ever known in a fighting force. Our Army needs leaders who are tactically and technically competent, stress fundamentals, enforce standards, and set the example. The Army wants all leaders to keep their integrity beyond reproach and to never overlook a breach of ethics in their subordinates. We also want leaders—from sergeant to general officer—who care for soldiers and their families. Leaders in our Army must treat soldiers and their families with the dignity and respect they deserve.

The day-to-day leadership of noncommissioned officers provides an appropriate balance between concern for soldier welfare and enforcement of standards in training and discipline. In recognition of their success in fulfilling the role of leader in our Army, Secretary Marsh and I have designated 1989 as the Year of the Noncommissioned Officer. Nowhere is the importance of the noncommissioned officer more apparent than in the Corps of Engineers, where sergeants must lead their soldiers in the performance of Herculean tasks, often in remote locations.

Our Army is committed to providing all leaders the education, experience, and opportunities to develop an ability for melding soldiers with doctrine and equipment to influence the course of the battle. We have such leaders today, but we must not rest on our laurels. Our challenge is to maintain this qualitative edge by continuing to develop outstanding young men and women to lead the Army and the Corps of Engineers into the 21st Century. Today's trained and ready Army is a tribute to the dedication and selfless service of engineer leaders, past and present, who used their ingenuity and resourcefulness to serve their Army and their country. As part of the combined arms team, Army engineers have always sought to increase tactical mobility by surmounting obstacles on the battlefield in ways that greatly increase agility in our combat capability. Engineers will be key to surmounting obstacles, of whatever form, that the Army will encounter in the future.

We face challenges in maintaining a trained and ready Army. We always have and always will. What will sustain us in the combined arms team is the spirit of excellence found in the Army Corps of Engineers, which answers every challenge with Essayons—"Let Us Try."

GEN Carl E. Vuono assumed his current duties as Army Chief of Staff in June 1987. He previously served as Commanding General, Training and Doctrine Command.

The following article summarizes MG Spigelmire's opening remarks at the April 1989 Infantry Conference, held at Fort Benning, Georgia.

Infantry is associated primarily with the close battle. While that remains our major contribution, I will discuss infantry's doctrinal participation across the spectrum of the AirLand Battlefield.

FM 100-5 states that an Army's fundamental doctrine is the condensed expression of its approach to fighting campaigns, major operations, battles, and engagements. It states that tactics is the art by which corps and smaller unit commanders translate potential combat power into victorious battles and engagements. Based on this, I will explain where infantry doctrine and its current initiatives fit into the combined arms AirLand Battles: deep, close, and rear operations.

Deep operations occur at any echelon and comprise activities directed against forces not in contact with friendly forces. They are designed to influence the conditions in which future close operations will be conducted.

In the critical area of intelligence preparation of the battlefield (IPB), it is difficult to integrate doctrine with weather and terrain and relate these factors to the mission and specific battlefield situation. Our charter in the proponent schools covers brigade and battalion operations. These units normally do not conduct separate deep operations, but they may be part of a deep maneuver operation. With this in mind, how does infantry assist in IPB development when orchestrating successful deep operations?

Long-Range Surveillance and Ranger Units (LRSU) are key players in this area. LRSUs provide the corps commander with a dedicated company, and they provide the division commander with a dedicated detachment. These units are specially trained at Fort Benning, Georgia, to collect reliable human intelligence (HUMINT) against second echelon and follow-on enemy forces. The governing doctrinal publication for these units, FM 7-93, was published by the Infantry School in June 1987. ARTEP 7-93, *Mission Training Plan*, was published in December 1988 to support this critical, deep-operation, intelligence-gathering tool.

Ranger regiments fight the enemy as a light infantry force. They follow infantry doctrine and observe all the basic rules of infantry operations. While Rangers conduct both strategic and operational missions, their efforts are combined into an overall plan to destroy, delay, and disorganize the enemy. The objective is to cause the enemy to divert his attention and combat forces to rear area security. Again, this contributes to successful deep operations in the AirLand Battlefield.

Infantry Combined Arms Doctrine Across The AirLand Battlefield

by MG Michael F. Spigelmire

FM 7-85, published by the Infantry School in June 1987, provides doctrine for Ranger units.

An example of infantry use in deep operations occurred during last year's Reforger exercise, Certain Challenge. The 1st Battalion, 87th Infantry, 10th Mountain Division was attached to the 2d Armored Calvary Regiment as part of a heavy-light operation scenario. During one phase of the exercise, the 1-87 Infantry was tasked to deploy quickly and conduct raids on enemy logistic sites and to sever lines of communication of the V Corps' main attack. The action was an unqualified success and proved the effectiveness of heavy-light operations.

Skillful employment of LRS, Ranger, and other infantry, and skillful use of IPB, assist senior commanders in their ability to influence deep operations.

We get closer to home when transitioning to close operations. By definition, close operations bear the ultimate burden of victory or defeat. The measure of success of deep and rear operations is their eventual impact on close operations. Doctrine is currently published (71 series) or being updated (7 series) to provide tactical concepts and techniques for mounted and dismounted infantry units—squad through brigade. In addition, these manuals emphasize the

Rangers conduct a patrolling mission through a Georgia swamp. Ranger operations are an integral part of the AirLand Battle.

What wins the close battle?

While opinions vary, the combat training centers have shown us that successful reconnaissance, security, and counter-reconnaissance are fundamental cornerstones of battlefield success.

importance of combined arms operations.

What wins the close battle? While opinions vary, the combat training centers have shown us that successful reconnaissance, security, and counter-reconnaissance are fundamental cornerstones of battlefield success. Yet, units have problems planning and executing these critical tasks.

I propose some recommended solutions:

- Integrate IPB, reconnaissance, and surveillance in planning and executing offensive and defensive operations.
- Structure our institutional courses to instill tenacity and aggressiveness during a reconnaissance.
- Ensure there are sufficient openings in our super scout—Ranger Course—to train students properly in field applications of reconnaissance and security.
- Examine equipment and materiel issues for a possible hybrid configuration of the cavalry fighting vehicle (M3) and the high mobility multipurpose wheeled vehicle (HMMWV).

Synchronization is another linchpin to successful close operations. Our doctrine stresses synchronization as a key element to victory in future battles. Yet there are indications that task force commanders have problems effectively synchronizing their part of the close battle. Initiatives such as the recent NTC White Paper on task force synchronization problems and the Tactical Commanders' Development Course (TCDC), being instituted by Fort Leavenworth to teach precommand course fundamental task force operations, are positive steps to overcome this problem area.

We recently instituted a combat system checklist at the Infantry School. The checklist incorporates key elements of the battle operating systems in a detailed, logical manner. It organizes a leader's synchronization thought process, which in turn facilitates synchronization itself. This, coupled with teaching combat systems integration and synchronization in our IOAC and PCC classes, are positive steps that will assist task force commanders in this important area.

Infantry leaders and commanders need to understand the critical contribution of artillery (fire support/ADA), logistics (CSS), intelligence, chemical (NBC), and engineers (mobility—countermobility—survivability). We are relearning the importance of obstacles, fighting positions, and other combat engineering skills.

The last critical element to the close battle is a proper understanding and use of reserve forces. The reserve forces and potential missions must be clearly designated and available for commitment at the decisive moment. Units assigned to this mission must be properly constituted and led to ensure they are integrated properly.

Rear operations have been described as activities at any echelon that are to the rear of elements in contact. They are designed to assure freedom of maneuver and continuity of operations, including continuity of sustainment, command, and control. Doctrinally, rear area installations that do not contribute immediate or continuous support to tactical operations are expected to defend themselves against all but the greatest threats during the critical periods of the battle. These threats, such as Soviet airborne forces or Speznatz personnel, can be countered effectively and quickly by properly placed infantry forces.

In summary, infantry units are capable and flexible forces. They are available for decisive engagements throughout the depth of the battlefield to assist in winning the combined arms battle.

MG Michael F. Spigelmire is the Commanding General of Fort Benning and the United States Army Infantry Center, Fort Benning, Georgia. He has a masters degree in international relations from Georgetown University and is a graduate of the U.S. Army Command and General Staff College and the U.S. Army War College.

IMPLEMENTING FM 25-100: Training The Force

by COL James H. Simms and
MAJ Robert Crear

"This article by COL James H. Simms , from the Engineer School's Directorate of Training and Doctrine, and MAJ Robert Crear, 1st Engineer Brigade, provides an excellent sample for implementing FM 25-100, 'Training and Force' at the unit level. It should prove useful to commanders from brigade to platoon levels."

MG Daniel R. Shroeder

In his chronology of World War II, Hugh M. Cole described the difficulty experienced by the 95th Division in its battle for the West Wall during December 1944. German pillboxes and bunkers abounded, and the fighting to drive the enemy from those positions was intense.

"The American engineers distinguished themselves in both the 90th and 95th Division zones during this bunker fighting. On 7 December the 95th Division After Action Report pays special tribute to the work of the 320th Engineer Combat Battalion. Enemy participants in these engagements agree in recognizing the 'bunker knack' of what they call the American 'special troops.' The bazooka was particularly valuable in this kind of fighting, despite its high percentage of misfires. Bazooka training had been neglected in the United States, and the 95th Division was forced to give such training immediately in the rear of the forward lines." *(The Lorraine Campaign,* by Hugh M. Cole, 1950)

This is just one example of an unforeseen training need. There are countless cases in the history of war. And each had a cost.

FM 25-100, *Training the Force*, is the Army's most important training manual. It describes a process that helps us foresee what we will do in war and identifies unit and individual training requirements. The process is "battle focus." The battle focus concept is simple: Identify things that a unit must do in war, and then train to do them. But, how does one start?

We start by recognizing an obvious fact: Units cannot train to proficiency on everything. We must limit our efforts to tasks needed to accomplish the unit's wartime mission. Those tasks are defined in a Mission Essential Task List (METL).

METL development begins at the top. The commander at each level—

- Determines a METL based on war plans and external directives;
- Selects, from the ARTEP mission training plan (MTP), tasks that support the given missions;
- Ensures the METL supports and complements the METL of the next higher headquarters (HQ) and the maneuver element he supports;
- Briefs the next higher commander, who approves the METL.

Examples of typical unit METLs, from battalion through squad levels, are shown below. Note that each is fully integrated with the unit's higher headquarters.

ENGINEER BATTALION METL DEVELOPMENT

The divisional engineer battalion commander develops a METL from three primary sources:

- Wartime missions and external directives. For example:
  "At C-day, H-hour, 64th Engr Bn deploys by air and sea, occupies assigned assembly areas, and organizes for combat. On order, conducts mobility operations in support of 1st Bde, 54th Inf Div, offensive operations."
- The next higher HQ METL. For example:
  "Conduct offensive operations."
- The supported unit's METL. For example:
  "Destroy an enemy force by conducting a rapid and decisive attack."

Information from these sources is analyzed, and then the battalion commander selects a METL from his

ARTEP. For example, he may select the following from ARTEP 5-145-MTP:

5-1-0002 Prepare an Engineer Estimate (Bn)
5-1-0003 Prepare an Engineer Annex (Bn)
5-1-0007 Prepare an Operations Plan/Order
5-1-0008 Conduct Combat Operations
▽
▽
5-1-0027 Perform Engineer Battlefield Assessment (Bn)
▽
▽
5-1-1000 Conduct Logistic Operations

Next, the battalion's METL is coordinated with the 1st Brigade and is approved by the division commander. It then becomes the basis for METL development by subordinate companies within the battalion.

ENGINEER COMPANY METL DEVELOPMENT

The company commander prepares the unit's METL in the same manner as the battalion commander. Information sources include—

- ▶ Wartime missions and external directives:
  "Co B, 64th Engineer Bn operates in direct support of TF Mech, 1st Bde, 54th Div and conducts mobility operations in support of offensive operations."
- ▶ The next higher HQ's METL:
  5-1-0008 Control Combat Operations (Extract from 64th Engr Bn METL, ARTEP 5-145-MTP)
- ▶ The supported unit's METL:
  7-1-3007 Assault (Extract from TF Mech METL, ARTEP 71-2-MTP)

The company commander compiles the unit's METL from tasks in ARTEP 5-145-31-MTP. For example:

Selected B Company's METL

5-2-0111 Conduct Minefield Clearing Operations
5-2-0113 Conduct Self-Extraction from Remotely Delivered Mines
5-2-0114 Conduct Breaching Operations
5-2-0600 Conduct River Crossing Operations
5-2-0603 Prepare Expedient Fords (Co)
5-3-0705 Construct Combat Roads/Trails
5-4-0009 Employ the AVLB
5-4-0011 Employ the CEV

The company commander coordinates the METL with TF Mech and briefs the engineer battalion commander, who approves the METL. The company METL then becomes the basis for task development by platoons in the company.

PLATOON TASK DEVELOPMENT

Each platoon leader applies the same process to develop training tasks. Information sources include:

- ▶ Wartime missions and directives:
  "1st Plt, B Co, 64th Engr Bn operates in direct support of Mech Team Charlie and conducts mobility operations in support of offensive maneuvers."
- ▶ The next higher HQ's METL:
  5-2-0014 Conduct Breaching Operations (Extract from B Co METL, ARTEP 5-145-31-MTP)
- ▶ The supported unit's METL:
  17-2-0326 Assault an Enemy Position (Mounted) (Extract from Mech Team Charlie METL, ARTEP 71-1-MTP)

The platoon leader develops a task list from those in ARTEP 5-145-11-MTP. A platoon's list might include the following tasks:

5-3-0043 Reduce Obstacles
5-3-0044 Support the Attack on Fortified Positions
5-3-0103 Conduct an In-Stride Breach of a Minefield
5-3-0705 Construct Combat Roads/Trails
5-4-0105 Improve a Vehicle Lane through a Minefield
5-4-0110 Mark a Minefield
5-4-0115 Conduct Minesweep Operations
5-4-0603 Prepare Expedient Fords

After this list is coordinated with the supported unit and approved by the company commander, it is used to develop squad tasks.

DEVELOPMENT OF SQUAD TASKS

The platoon leader and platoon sergeant use ARTEP 5-145-11-MTP to identify squad and individual tasks that support those in the platoon's task list. For example, they identify the following squad tasks to support platoon task 5-3-0103, Conduct an In-Stride Breach of a Minefield:

5-4-0105 Improve a Vehicle Lane through a Minefield
5-4-0110 Mark a Minefield
5-4-0115 Conduct Minesweep Operations

They also identify the Soldier Training Publication (STP) individual task summaries that support the squad tasks above. In this example, the following tasks are identified:

Skill Level 4
051-192-4052 Direct Minefield Clearing Operations
051-195-4007 Determine Logistical Requirements for Wire Entanglements
051-195-4050 Prepare Engineer Estimates

Skill Level 3
051-192-3050 Direct a Mine Sweeping Team
051-195-3003 Direct Construction of Wire Entanglements

Skill Level 2
051-193-2030 Clear Misfires

Skill Level 1
051-192-1021 Locate Mines by Visual Means
051-192-1022 Locate Mines by Probing
051-192-1023 Locate Mines Using the AN/PSS-11 Mine Detector
051-192-1040 Locate Mines Using Non-Metallic Mine Detectors
051-193-1001 Use and Maintain Demolition Equipment
051-193-1002 Construct a Nonelectric Initiating/Detonating System
051-193-1003 Prime Explosives Nonelectrically
051-193-1004 Construct an Electric Initiate ing/Detonating Assembly
051-193-1005 Prime Explosives Electrically
051-193-1007 Prime Explosives with Detonating Cord
051-193-1011 Install Dual Firing Systems
051-193-1013 Neutralize Booby Traps
051-195-1004 Install Pickets, Make Barbed Wire Ties, and Install Concertina

This step completes the METL development process. The company commander, in concert with the first sergeant, platoon leaders, and platoon sergeants, now prepare the company's training program.

THE COMPANY TRAINING PROGRAMS

After the METL and supporting individual tasks are compiled, the next critical step is to assess unit and individual proficiencies in these tasks. The near-term, short-range, and long-range training plans are based on this assessment, as discussed in FM 25-100.

Company training plans must be coordinated with those of the supported maneuver unit and other "slice" elements. Successful combined arms training will result if plans are carefully linked.

The battalion commander's role in preparing the company training program is important. He approves the plans and—even more critically—works to protect the integrity of the company plans.

INTEGRATION OF BATTLE DRILLS

Battle drills provide an effective bridge between collective METL tasks and supporting individual tasks at the squad level. For example, the following battle drills from ARTEP 5-145-Drill provide training for squad task 5-4-0115, Conduct Minesweep Operations, and the supporting individual tasks:

- Clear a Footpath Through an Obstacle With a Bangalore Torpedo, and
- Breach a Minefield With Hand-emplaced Explosives.

These and other drills are an excellent means of achieving individual and small unit battle competencies in METL tasks.

CONTINUOUS CYCLE

Battle focus is a continuous process: An assessment results in a plan, which is implemented. The training results are assessed, adjustments are planned and executed, and the process continues. Leaders at all levels take charge throughout the process. They accept the responsibility, hold each other accountable, and ensure execution to standards.

If battle focus is successful, perhaps there will be no more bazooka incidents like that described at the beginning of this article. Instead, there will be successes similar to that experienced by General Winfield Scott's soldiers during the War of 1812.

What kind of success? Read FM 25-100 and find out.

Notes: ARTEP 5-145-MTP (Headquarters and Headquarters Company, Engineer Battalion, Heavy Division/Corps), ARTEP 5-145-31-MTP (Engineer Company, Heavy Division/Corps/Armored Cavalry Regiment), and ARTEP 5-145-11-MTP (Combat Engineer Platoon, Heavy Division/Corps/Armored Cavalry Regiment), dated February 1989, were distributed in April.

ARTEP 5-145-Drill was distributed as a coordinating draft in April 1989. Final print and distribution is programmed for October 1989.

COL James H. Simms assumed command of the 937th Engineer Group, Fort Riley, in July 1989. His previous assignment was Deputy Director, DOTD, USAES, Fort Belvoir. COL Simms holds an M.S. in engineering management from the University of Missouri-Rolla and is a graduate of the National War College.

MAJ Robert Crear is the Operations and Training Officer of the 1st Engineer Brigade at Fort Leonard Wood. He holds a B.S. degree in mathematics from Jackson State University, Mississippi, and is a graduate of the Command and General Staff College.

German Combat Engineer Support in the Combined Arms Battle

by LTC Klaus Wilke

The Bundeswehr (Federal Armed Forces of Germany) exists to safeguard peace and is a prerequisite for a policy of détente. The Bundeswehr, which provides the biggest contingent of conventional NATO troops in Europe, has three tasks:

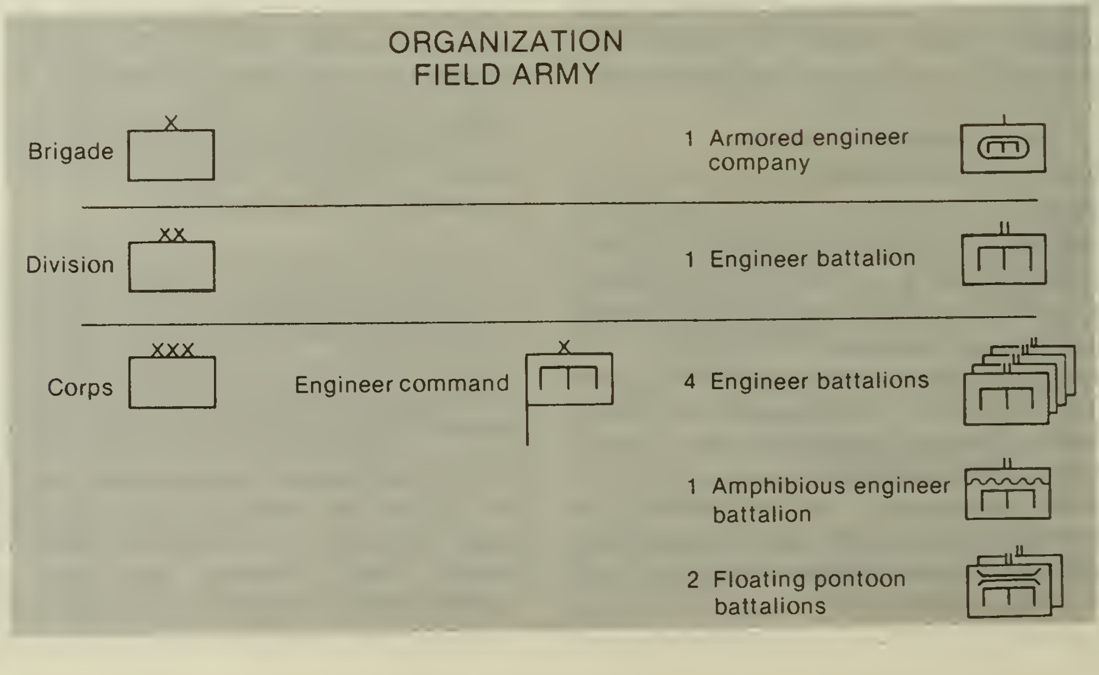
- In peacetime, together with allied troops, it works to deter an enemy from threatening or using military force against the Federal Republic of West Germany. The Bundeswehr maintains constant operational readiness to accomplish this mission.
- In crisis, it helps political leaders to negotiate without having to submit to foreign political will.
- In a state of defense, it preserves or restores the inviolability of the territory of the Federal Republic. This is achieved through a joint defensive effort with allies near the border (forward defense).

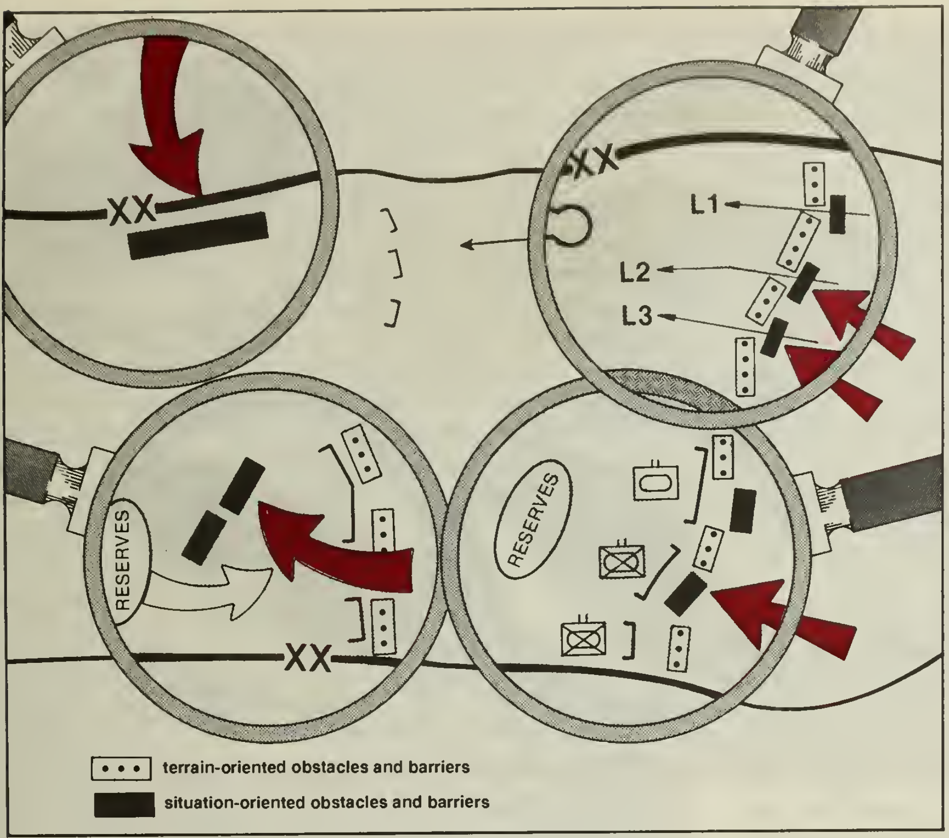
Bundeswehr army field forces are assigned by NATO and are organized into three corps, including 12 divisions and 36 brigades. German engineers are an organic part of the Army. Their primary mission is countermobility, followed by (in descending order) mobility, survivability, and general support.

Combat troop operations require dynamic engineer support. The support must be fully integrated in the combined arms battle, primarily when engaging armor. Combat troop support must adapt to a highly mobile battle and the increasing speed of various battle stages. It includes countermobility operations that pull combat troops out to make them available for operations in areas where decisive battles are fought. Engineer support in these areas cannot be strong enough.

The first critical task of engineers is to effectively support the combat troops' early efforts to paralyze the enemy's mobility. At the same time, they must preserve the mobility of friendly forces.

The ability to reconnoiter and negotiate natural and man-made obstacles in a timely manner, especially minefields, is the engineers' second critical task. The aim here is to maintain the thrust and mobility of major friendly units. In units used mainly offensively, this task may have priority over countermobility




XX
L1
L2
L3
RESERVES
XX
RESERVES
terrain-oriented obstacles and barriers
situation-oriented obstacles and barriers

operations. Because state-of-the-art mine sensor devices make breaching operations increasingly difficult, more reliance is placed on minefield reconnaissance to eliminate, from the very beginning, the need for breaking through minefields.

In defensive operations, current battlefield doctrine makes countermobility operations a critical factor in the combined arms battle. Harmonized with current operational planning, such operations deprive enemy assault forces of their thrust and speed. The purpose is to contain enemy leading elements, causing the first echelons to congest, and then to destroy them by fire. Successful countermobility operations create the preconditions for successful friendly counterattacks into the enemy's flanks and rear.

Use of the new German countermobility capabilities is predicated on continuous synchronization of the competing elements of mobility and countermobility. Synchronization begins in the obstacle planning process and is part of operational planning at the tactical command post. It is used to direct countermobility operations at that level.

"Terrain management" describes the purpose and objective of the synchronization efforts. Under this concept, the engineer commander advises the major commander and his staff within the command control process on ways to improve or reduce trafficability in terrain sectors. The engineer commander proposes points of main countermobility efforts and required situation-related changes. He also selects and monitors the active life of scatterable mines and plans obstacle-free areas and minefield gaps. Obstacle planning ensures that a system of barriers and obstacles responsive to tactical requirements is available on the battlefield at the right time.

Proper obstacle emplacement is based on terrain evaluation and an estimate of the enemy situation. Obstacles are emplaced before hostilities break out only where enemy attacks are anticipated but large-scale movements of friendly forces are not planned. These terrain-oriented barriers force the enemy into an early deployment and slow down the rapid introduction of enemy troops. They provide time for the initial deployment of friendly forces and the establishment of defense readiness.

Peacetime-prepared obstacles and sophisticated engineer explosives and related materiel considerably reduce the time required for the emplacement of such obstacles. They include road craters and bridge demolitions. Upon declaration of alert measures, these prepared countermobility operations will be continued in the depth of the battlefield in a manner adapted to the development of the changing situation. Preplanned, terrain-oriented obstacles provide the backbone of the general defense plan (GDP) obstacle planning.

For obstacles to reach their maximum effectiveness, they must be fully integrated into the combined arms battle. They must be synchronized with fire support and planned movements of combat units. Therefore, in battle, terrain-oriented obstacles are supplemented with situation-oriented barriers.

To enhance the effectiveness of these measures (the combination of situation and terrain-oriented targets), artillery units deliver scatterable minefields with multiple rocket launchers. They are target-oriented in front of friendly units and on the flanks, even in areas occupied by the enemy. Their purpose is to prevent the rapid introduction of fresh enemy forces.

Thus, terrain-oriented, situation-oriented, and target-oriented obstacles are combined to form one interlocking system.

Barrier planning is not used only to determine the locations of main countermobility efforts. It must also impose restrictions, such as vehicle lanes and obstacle-free areas. If it is true that a battle is always won during its offensive phase, then the locations of obstacle-free areas may have a greater impact on operational freedom than any decision regarding the concentration of countermobility efforts.

Barrier operations contribute significantly to battle success if they are properly conducted, adapted to operational planning requirements, and flexibly directed. To be successful, the engineer commander must be involved in the planning and decision-making process at the tactical command post.

To execute these barrier operations, German engineers are equipped with sophisticated equipment, including the minelaying system 85, SKORPION, and off-route antitank mines.

Minelaying system 85 replaces the first generation of conventional antitank mines. This mine system has a full width action hollow-charge mine that can be laid either mechanically or by hand. The mine has a magnetic fuse, which senses when a vehicle passes over it. It has an anti-lifting and a blast-resistant device. The mine-layer emplaces the antitank mine automatically, either by burying it or by laying it on the surface. After a laid life of 40 days, the mine neutralizes itself and indicates its position.

Minelaying system 85 is best used in preplanned, terrain-oriented countermobility operations. It is used to prevent enemy forces from breaking through areas where no movements of friendly armored units are expected. Minefields of this type provide the backbone of the countermobility system.

SKORPION, a scatterable mine system, complements the mechanical minelaying system 85. It is intended mainly for situation-oriented barrier operations. SKORPION is used to lay extensive minefields near combat forces with little manpower effort and within a few minutes. For example, one SKORPION system can lay a minestrip that is 1000 meters (m) long and 80m wide in 10 minutes.

To be successful, the engineer commander must be involved in the planning and decision-making process at the tactical command post.

The scatterable antitank mine, AT2, is a shaped charge mine with an electronic fuse that detonates across the entire width of a passing vehicle. A choice of one to six possible detonation times (between 3 and 96 hours) allows the major commander to determine the life of a barrier in accordance with the tactical mission.

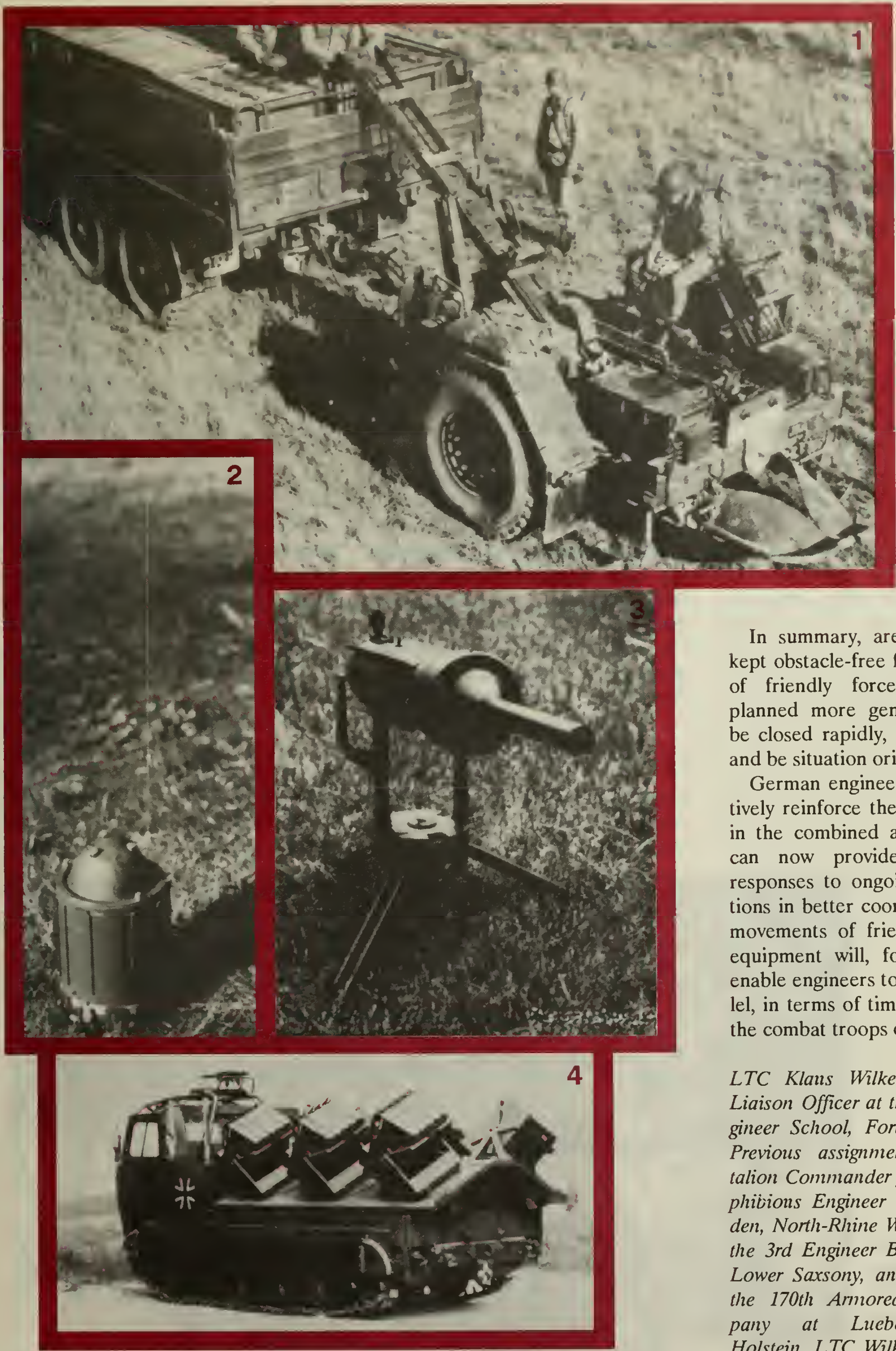
The scatterable mine system provides direct support to combat units engaged in delaying operations, particularly when disengaging or in defensive operations in the depth of the defensive area. It can protect flanks and close gaps between obstacles rapidly. The system can temporarily close areas earmarked for friendly movements that must be clear of obstacles before or after a given point of time.

The off-route antitank mine closes an equipment gap in mine warfare. It permits rapid blocking of roads and lanes without the need for extensive preparations. It can close gaps between obstacles and lanes, reinforce minefields, and deny the enemy use of crossing sites. Well suited also for combat in built-up and wooded areas, the off-route antitank mine is laid by hand. It has switch-on/switch-off capabilities and can launch a projectile 40m. This antitank mine has a lifetime of 40 days and can be relifted and reused.

All German combat engineer companies primarily engaged in countermobility operations are equipped with minelaying system 85. Armored engineer companies and engineer companies organic to divisional engineer battalions hold, as additional equipment, the SKORPION mine launching system and large numbers of off-route antitank mines. This equipment enables companies to sustain countermobility operations for several combat days without ordering additional mines.

These minefield capabilities provide several advantages:

- They are emplaced mechanically and can be used to close large terrain sectors rapidly.
- Minefields need no longer be backed up by natural obstacles. Any type of terrain can be closed.
- Mine systems can be mixed with other types of antitank weapons in situation-oriented joint endeavors. By mixing systems, we increase combat power, disencumber the combat troops, and complicate enemy attempts at neutralization.
- They considerably enhance the capability to concentrate countermobility efforts, to reinforce countermobility forces, and build countermobility reserves.



1. Minelayer system
2. AT2 (antitank mine)
3. Off-route antitank mine
4. SKORPION scatterable mine system

In summary, areas that must be kept obstacle-free for the movement of friendly forces can now be planned more generously and still be closed rapidly, even temporarily, and be situation oriented.

German engineers can now effectively reinforce the antitank defense in the combined arms battle. They can now provide rapid, flexible responses to ongoing tactical situations in better coordination with the movements of friendly forces. This equipment will, for the first time, enable engineers to operate in parallel, in terms of time and space, with the combat troops on the battlefield.

LTC Klaus Wilke is the German Liaison Officer at the U.S. Army Engineer School, Fort Leonard Wood. Previous assignments include Battalion Commander for the 130th Amphibious Engineer Battalion at Minden, North-Rhine Westphalia, XO for the 3rd Engineer Battalion at Stade, Lower Saxony, and commander for the 170th Armored Engineer Company at Luebeck, Schlwswig-Holstein. LTC Wilke graduated from the German Army Officers School and the German Engineer School.

THE NCO CORPS

by CPT Robert B. Carroll

Look at what has happened to our NCOs! The NCO corps has recently undergone a remarkable transformation. Today's NCOs have more ability than ever before, as shown by their improved tactical competence and the sense of confidence displayed in the field. During this "Year of the NCO," I am compelled to notice and pay tribute to our NCOs, the backbone of the Army. The stature, strength, and stability of the future Army will continue to depend on the quality of our NCOs.

As an engineer, I call attention to SGT Joe C. Specker. His name was given to Fort Leonard Wood's barracks complex in honor of his gallantry beyond the call of duty.

On the night of 7 January, 1944, SGT Specker advanced up the slope of Mount Parchia, Italy, with his company. After returning from a reconnaissance mission, SGT Specker reported that an enemy machine gun nest and several well placed snipers were directly in their path, awaiting the company. The sergeant made his way up the mountain to place a machine gun and a box of ammunition near the enemy's position. He was observed by the enemy and wounded. Although so seriously hurt he could not walk, SGT Specker dragged himself over the jagged edges of rock and rough terrain until he reached a position where he set up the machine gun. His accurate firing silenced the enemy

Squad members emplace triple strand concertina during a battalion field exercise on Fort Leonard Wood, Missouri.

MOVES FORWARD

machine gun nest, and the rest of the snipers were forced to retire. SGT Specker's actions enabled his platoon to obtain their objective, but he was found dead at his gun. History is replete with similar heroic actions by NCOs.

When I was a platoon leader in 1981, I heard that the NCO corps lacked the competence they formerly possessed. I heard these rumors, yet I saw NCOs adjusting to rapidly changing standards. Alcohol abuse and the use of marijuana and other illegal drugs were problems in my platoon, although these problems were not exclusive to NCOs. The Army's overweight program was new at the company level. The minimum General Technical (GT) score for reenlistment was beginning to rise, and the Army Physical Fitness Test (APFT) had just changed.

Thus, for the first time in many years, we began to tackle our personnel problems. Gradually, almost without notice, the standards for NCOs were rising.

By the time I commanded in 1988, my NCOs more than fulfilled the adage that NCOs run the companies and officers command them. Most of the personnel problems I confronted as a platoon leader had all but disappeared.

Today, NCOs lead by example, and competition among NCOs within a unit is high. Their leadership includes a sense of caring for soldiers that continues around the clock. Their knowledge and job skills have improved because they continually seek more military and civilian education. For example, in my unit NCOs recently planned and executed a week-long field training exercise (FTX) at the battalion level to test common soldier skills.

What caused this transformation? Much can be attributed to a change in our society and command philosophies. Society now places more emphasis on wellness and care for families, training, and education. Most of these attributes have been used as annual themes by the Army.

A significant change in the Corps of Engineers was the elimination of basic and primary technical courses (BTC and PTC) in favor of the Primary Leadership Development Courses (PLDC) and Basic Noncommissioned Officer's Course (BNCOC). PLDC and BNCOC ensure that each career field is tactically and technically competent.

To improve leadership, the Engineer School implemented common leadership training (CLT) into both the BNCOC and Advanced Noncommissioned Officer's Course (ANCOC). CLT ensures that NCOs across the Army are competent and confident in leadership skills and management techniques. CLT was developed for the NCO corps by the NCO corps. The U.S. Army Sergeants Major Academy (USASMA) developed Phase I, and the Engineer School "branch flavored" training in Phase II.

Engineer branch flavoring was added to BNCOC by integrating engineer branch history, maintenance, and FTX. Nuclear, biological, chemical (NBC) training, graves registration, supply management, casualty reporting, automated communications and electronics operation instructions (CEOI), and combat orders are now included in FTX. CLT in ANCOC includes

During this "Year of the NCO," I am compelled to notice and pay tribute to our NCOs, the backbone of the Army.

continuous operations performance, communications, battlefield supply, NCO history, route reconnaissance, minefields/wire obstacles, and computer literacy.

To improve tactical competence with hands-on practice, initial entry training (IET) was integrated with the BNCOC courses during FTXs. The combat arms tactical exercise (CATEX) integrates 12B BNCOC students with 12B, 12C, and 12F IET soldiers. The combat heavy exercise (CHEX) integrates 51H and 62N BNCOC with IET soldiers in both the 51 career management field (CMF) and 62 CMF.

A future goal, which may be implemented in the 1990s, is to integrate the Engineer Officer Basic Course (EOBC) and ANCOC into a combined arms FTX. In this unique training environment, ANCOC and BNCOC students will have an opportunity to interact with and perform the duties of platoon sergeants and squad leaders.

Excellence in the NCO corps is invaluable. When the Engineer School completes the move to Fort Leonard Wood this year, the Corps of Engineers will enter a new era. Future officers, noncommissioned officers, and enlisted soldiers will train on the same installation. This will ensure that the proper level of attention and direction are given to NCO training and professional development.

The Engineer School's move to Fort Leonard Wood is raising new questions. For example, to what extent can shared training be achieved with improved results? We don't know, but I am sure that the answer to this and future challenges will be met with the same dedication, skills, and leadership we have grown to expect and admire from our NCOs.

CPT Robert B. Carroll is assigned to the Directorate of Training and Doctrine, U.S. Army Engineer School, Fort Leonard Wood. He has a degree in forestry from North Carolina State University.

Obstacle courses are used in the Leadership Reaction Course at Fort Leonard Wood, Missouri, to teach leadership skills.

Providing Power in War and Peace

All In a Day's Work

by Alexandra K. Stakhiv

What do Johnston Island, Guam Island, and the Kwajalein Atoll have in common besides being islands located in the West Pacific? They are locations where the U.S. Army Engineering and Housing Support Center (the Center) has recently responded to requests for power assistance. Each request required working with a different agency or service to provide temporary power while new equipment was being installed or old equipment repaired and overhauled.

A field operating activity of the U.S. Army Corps of Engineers, the Center manages the Army's prime power program and power engineering support capabilities. One of the Center's major responsibilities is to acquire and manage an inventory of prime power generators and to provide military personnel to execute the program.

Whenever prime power equipment is needed, the Center coordinates with the U.S. Army Troop Support Command (TROSCOM) to have a power plant released from storage and sent to the proper location. By ship, rail, or air, the Center can deliver virtually anywhere in the world.

Another responsibility of the Center is to maintain readiness for mobilization and war, while coordinating and managing power plant deployments for peacetime uses and exercises. Prime power production specialists (MOS 52E) are trained at the Center to accomplish this mission. They operate, maintain, and repair prime power equipment and deploy with it for real-life requirements and major field training exercises, such as Bright Star, Gallant Eagle, Reforger, and Fuertes Caminos (Honduras).

Within the Center, the field detachments are the key operational element, and their mainstay is the prime power production specialist. Six detachments work in tandem with the Center's Directorate of Prime Power and Emergency Operations. Located all over the world, the detachments consist of prime power teams and headquarters teams.

The Center maintains two barges, the *Impedance* and the *Weber*, which can put out steady power at 30 and 22 megawatts (MW), respectively. Although somewhat slow-moving, these barges have a major strategic significance and deserve special mention. In wartime, their power capabilities could help reconstitute power supplies for strategic facilities such as those located in the Panama Canal.

Most of the time, however, the barges are loaned by the Army to the State Department. They assist in carrying out United States Agency

The Impedance, built in 1943 to assist in the war effort, is the older of the two base station plants operated by the Center. It can put out 30 MW of steady power, which is enough power for a small city of about 12,500 people.

for International Development (USAID) nation-building functions by helping third world countries. The training provided to people in these countries, incident to barge operations, helps them prepare for operating their own future power plants while the barges provide electrical power.

The *Weber* served in the Dominican Republic for 10 years. Currently undergoing an overhaul at the U.S. Navy Ship Repair Facility, Subic Bay, in the Philippines, she will head for Guam in early 1990. The *Impedance* is still providing power to the Dominican Republic, as she has since 1986.

In peacetime, the Center deploys power plants to meet prepositioning requirements of unified and specified commands. The Center supports installation Army directorates of engineering and housing (DEH), Army major commands, other Department of Defense (DOD) agencies, and occasionally, other countries with valid needs or as emergency loans. As far as the Center is concerned, a valid need is never turned down within DOD. However, the Army's needs have priority, followed by those of other services, and then, other government agencies.

Three recent examples of the Center's activities have soldiers from Detachment IV, stationed in Hawaii and Korea, fulfilling requests from three DOD agencies in three areas of the West Pacific. Within the space of a few months, they helped the U.S. Army, Navy, and Air Force to maintain their supply of electrical power in these isolated locations. It was not easy.

In June 1988, the Center received a request from the Army at Kwajalein Atoll for power assistance. As part of an upgrade of the electrical power distribution system, they needed to replace a primary distribution circuit at the atoll. No power would be available to the occupants while the circuit feeding a 136-unit family housing area and other critical facilities was being replaced. The atoll lacked the type of generators needed to provide power on a secondary line.

The Center sent three 750 kilowatt (KW) Fermont generators to the Kwajalein Atoll, and Detachment IV provided the personnel. SFC Michael Mercer headed the team, and they quickly connected the units to the distribution system. The generators provided power for two weeks while the new electrical power distribution system was installed. The generators were then removed and shipped back to the United States. "It was a good mission," said SFC Mercer. "The power stayed on and most people did not even notice that something different was happening."

Another mission involved the island of Guam, where some of the electrical power is provided by the Navy Public Works Center. The Navy needed to overhaul two of its power plants, and the remaining power plants could not provide enough electrical power for the island. Anderson Air Force Base, located on Guam, could not accept rolling, three-hour-on and three-hour-off electrical power rationing. Concerned about the adverse impact on soldier morale and the base's mission, the Air Force personnel contacted the Center.

Two 4.5 MW power plants were sent to Guam from Oakland, California. While the Air Force prepared the site to Army specifications, personnel from Detachment IV shipped the tools and equipment needed to install the plants. A five-man team, led by SFC Robert Huddleston, was dispatched to the island. The team first installed and tested the plants and then trained Air Force and civilian personnel to operate and maintain them.

Pleased with the mission, SFC Huddleston stated that "The Air Force worked well with us, providing excellent support and coordination. They helped us modify and make required parts for the power plants and were willing to help in any way they could." The Air Force later presented SFC Huddleston and his men with the Air Force Achievement medal for their assistance.

Almost as soon as the new plants were in place at Guam, an emergency occurred at Johnston Island. This island is the site of a chemical agent disposal system operated by the Defense Nuclear Agency (DNA). The site's major function is to demilitarize chemical agents.

"The Air Force worked well with us, providing excellent support and coordination."

SFC Richard L. Ford (left) and SSG William Worrell (right) install a turbo charger at Kwajelain Atoll.

SSG Robert Baker makes inner connections to the power plant at Anderson Air Force Base on Guam.

Congress mandates the activity, which requires reliable power.

The power plants on Johnston Island were 25 years old and subject to severe mechanical problems, resulting in frequent power outages. The generators simply could not provide enough power. The DNA estimated that each day their chemical agent disposal system did not operate cost them $100,000.

In July 1988, within two days of receiving the request for standby power assistance, the Center air shipped six 750 KW Fermont generators from Fort Belvoir, Virginia. Detachment IV again provided the personnel. By September, the team, under the leadership of SFC Ralph Simmons, had provided more than 1,000,000 KW hours of power to the island. The team worked three shifts per day without any relief.

The Fermont generators, the first phase of the Center's plan, were a short-term solution. As soon as two 4.5 MW power plants could be overhauled and shipped to Johnston Island from the United States, the second phase began. The team, again led by SFC Simmons, was expanded with personnel from detachment headquarters.

After the 4.5 MW power plants were installed and the island's personnel were trained to operate and maintain them, the Fermont generators used in the first phase were shipped back to Fort Belvoir. SFC Simmons and his crew returned to their home stations for a well deserved rest. However, they had to remain available on short notice, in case anything went wrong. The team also remained responsible for inspecting all units annually to ensure proper maintenance and performance.

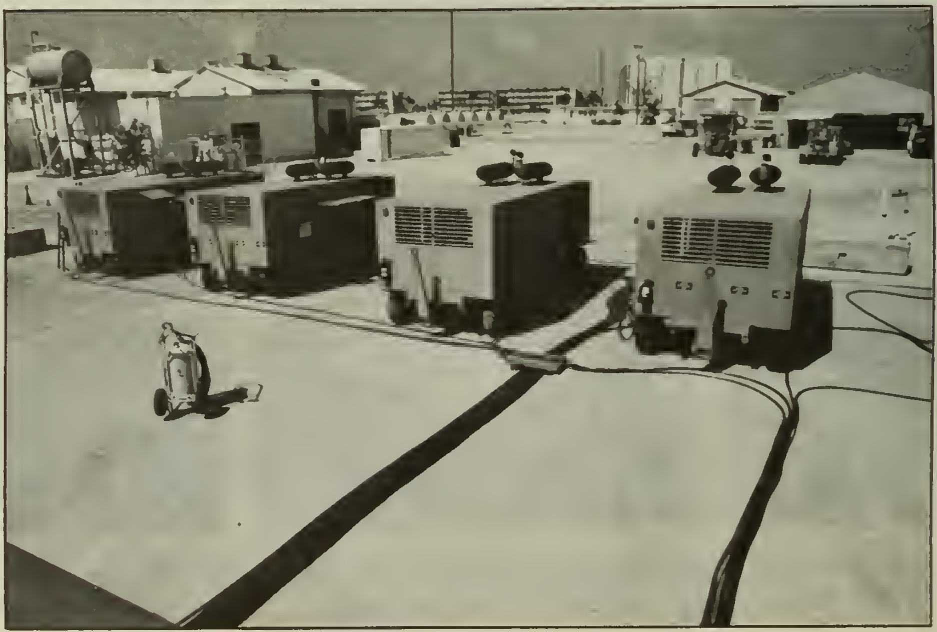
SFC Simmons described the experience as satisfying but very tiring. "We worked from 6 July to the end of October without any time off. We had to be on line providing power for the island every day. It was tough, but then that is what we are here for. Providing power may not sound too exciting, but, believe me, it can be. Both people and equipment require electricity. That is what we provide and that is what they need."

Day after day, month after month, the detachments from the Center provide power all over the world, from Korea to Europe. Their mission in peace closely parallels their mission in war. There are no training exercises merely for the sake of training, and no extra days off.

Chief Warrant Officer Michael Slobojan, Commander of Detachment IV, has several new projects in the wings. One that recently cleared through the State Department involves the island of Ponape, Federated States of Micronesia. "I have enough work on my desk to keep another 25 men busy for the next year," says CWO Slobojan. "Between Johnston Island, Kwajalein Atoll, Guam, Hawaii, Korea, and all the islands in the Pacific Basin, we do a lot of good for a lot of people. Maybe they don't see it, but we know it, and it makes us proud to be part of the Center and its mission. And best of all, we become a better trained resource for the Army when we are needed."

So what do Ponape Island, Kwajalein Atoll, Guam, and Johnston Island have in common? They are the latest additions to a list that grows as the Center's prime power specialists continue to provide power in war and in peace.

Alexandra K. Stakhiv is a technical writer/editor for the U.S. Army Engineering and Housing Support Center. She holds a Bachelor of Arts degree in English from the City College of the City University of New York.



In the foreground are four of the six Fermont generators used during the first phase of the Center's support to Johnston Island.

A PLACE CREATED ESPECIALLY FOR ENGINEERS

The North Dakota Army National Guard Engineer School provides outstanding qualification training for combat engineers (12B) and bridge crewmen (12C). Successful future battles will be determined by superior leadership and technical skills. Formal schools for military occupational skill (MOS) qualification and MOS-specific phases of noncommissioned officer education help ensure this proficiency.

Headquarters, Sixth U.S. Army, recognized the impact of the new noncommissioned officers' education system (NCOES) requirements on individual soldiers and their unit. With courseware and guidance provided by the Engineer School at Fort Leonard Wood, the North Dakota Army National Guard implemented a complete program of 12B and 12C training. As a result, a validated and approved MOS qualification program is now conducted for reassigned and prior service personnel at Camp Grafton. Comprehensive Phase II courses complete the NCOES basic and advanced programs.

The 12B and 12C courses conducted at Camp Grafton are designed to fully qualify a soldier in 15 days. This eliminates the need to

The terrain of Camp Grafton South is similar to the steppes of Europe, where many experts believe the major defense of Europe will be staged.

by MAJ Richard T. Aukland

Engineer installing overhead anchorage system for M4T6 float bridge.

use valuable inactive duty training (IDT) weekend assemblies to accomplish qualification. The program offers continuity to the training, which enhances the retention of learning objectives.

Breaching Soviet minefields, demolitions, land navigation, obstacles, bridging, field fortifications, and reconnaissance are some of the instruction blocks in which students receive training. Bridging includes training for M4T6, Bailey, timber trestle, light tactical raft (LTR), and medium girder bridges (MGB).

Training days are long and hard, yet rewarding. In addition to classroom work, students use a hands-on approach to accomplish learning objectives. They actually construct the various bridges and take turns on the different crews. They learn crew functions and responsibilities and proper construction methods. During reconnaissance training, students recon nearby roads and bridges, make calculations, and use terrain analysis techniques. Knowledge gained from classes and field training is used to develop a target folder. Breaching an emplaced Soviet minefield that contains inert Soviet wood mines and live-fire demolitions adds realism to the training.

At Camp Grafton, training for 12C soldiers includes the jet-powered, bridge erection U.S. combat support boat, MK2. Students learn proper preventive maintenance checks and services (PMCS) procedures and launching and retrieving techniques. Then they operate the boats in Devils Lake.

Cold weather training and survival courses are also available at Camp Grafton. A full complement of cold weather equipment, including, skis, ahkio sleds, arctic tents, stoves, snowmobiles, and winter camouflage clothing are available.

Engineer training during cold weather operations offers unique challenges. Operating heavy equipment, bridging, minefield construction, and other engineer tasks take on a new perspective, and soldiers must learn how to perform their mission and survive in a cold weather environment. Winter temperatures often drop to 30 degrees below zero, and 20 to 30 inches of snow are common. The terrain of Camp Grafton South is similar to the steppes of Europe, where many experts believe the major defense of Europe will be staged. Thus, units have an excellent opportunity to train in conditions similar to those where cold weather combat operations may be conducted.

The school is located at Camp Gilbert C. Grafton, near Devils Lake, North Dakota. The facilities and training areas are superb. A new armory and classroom complex were constructed in 1985, and an all-weather, battalion-sized barracks and dining facility were completed in 1986.

A large contonment and support area at Camp Grafton offers 1500 acres of maneuver space. Camp Grafton South has an additional 8000 acres where battalion-sized units practice such space intensive training as obstacles, field fortifications, tank ditches, and minefield construction.

The State of North Dakota and the National Guard spent much time, energy, and resources developing Camp Grafton as a

Engineers construct a Bailey Bridge at Camp Grafton, where temperatures can drop to 30 degrees below zero.

premiere engineer training facility. In addition, the North Dakota Military Academy has developed an extensive cadre of experienced and highly motivated instructors. Many of them receive refresher training at Fort Leonard Wood to stay current on engineer doctrine.

Engineers will play a vital role on the next battlefield. Maneuver commanders are confident that they can rely on engineer expertise to provide the "combat multiplier" necessary to successfully engage a force superior in number. As Major Harold Coyle, an armor officer, stated in his book, *Team Yankee*, "If used correctly before the battle, a platoon of engineers with heavy equipment can be more valuable than a company of tanks."

The North Dakota Army National Guard Engineer School is dedicated to provide the best training possible to ensure combat readiness. The training and methodology received by students will be carried back to their home units. This expertise will foster more detailed and innovative training programs and enhance unit readiness throughout the reserve structure.

Individuals and units interested in learning more about the school and the training facilities at Camp Grafton should contact the North Dakota Plans, Operations, and Training Officer, COL Jerome A. Marschke, at AV 344-5146, commercial (701) 224-5146. Or, call MAJ Richard T. Aukland, Academy Training and Operations, at AV 344-5226, ext. 411, commercial (701) 662-2171, ext. 411..

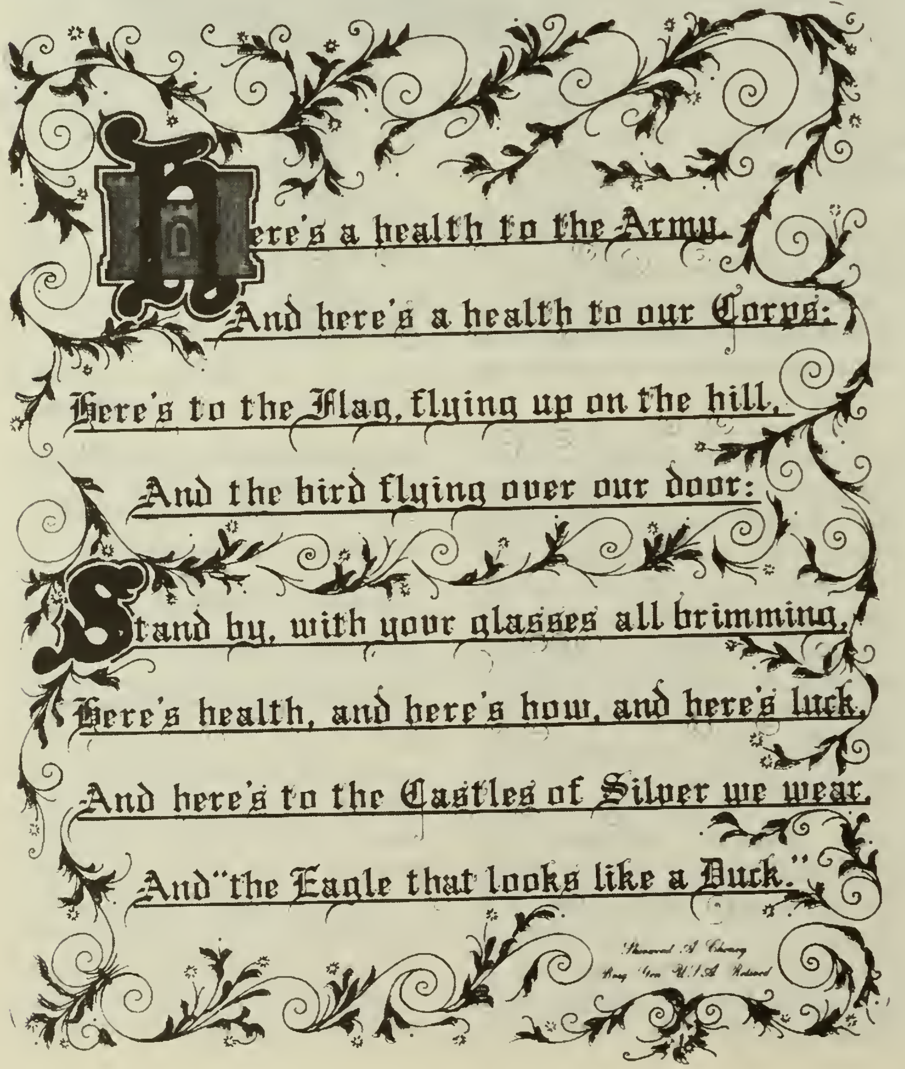
MAJ Richard T. Aukland is the Operations Officer for the North Dakota Military Academy. He is a graduate of the Command and General Staff College and has a masters degree in education administration.

Units have an excellent opportunity to train in conditions similar to those where cold weather combat operations may be conducted.

The Eagle that Looks Like a Duck

by Robert K. Combs

In the fall of 1898, as the U.S. Army was recovering from it's Spanish-American War adventures, a young engineer officer sat in the officers mess at Willets Point, Long Island, New York. This young engineer, who would retire years later as BG Sherwood A. Cheney, authored the toast below.



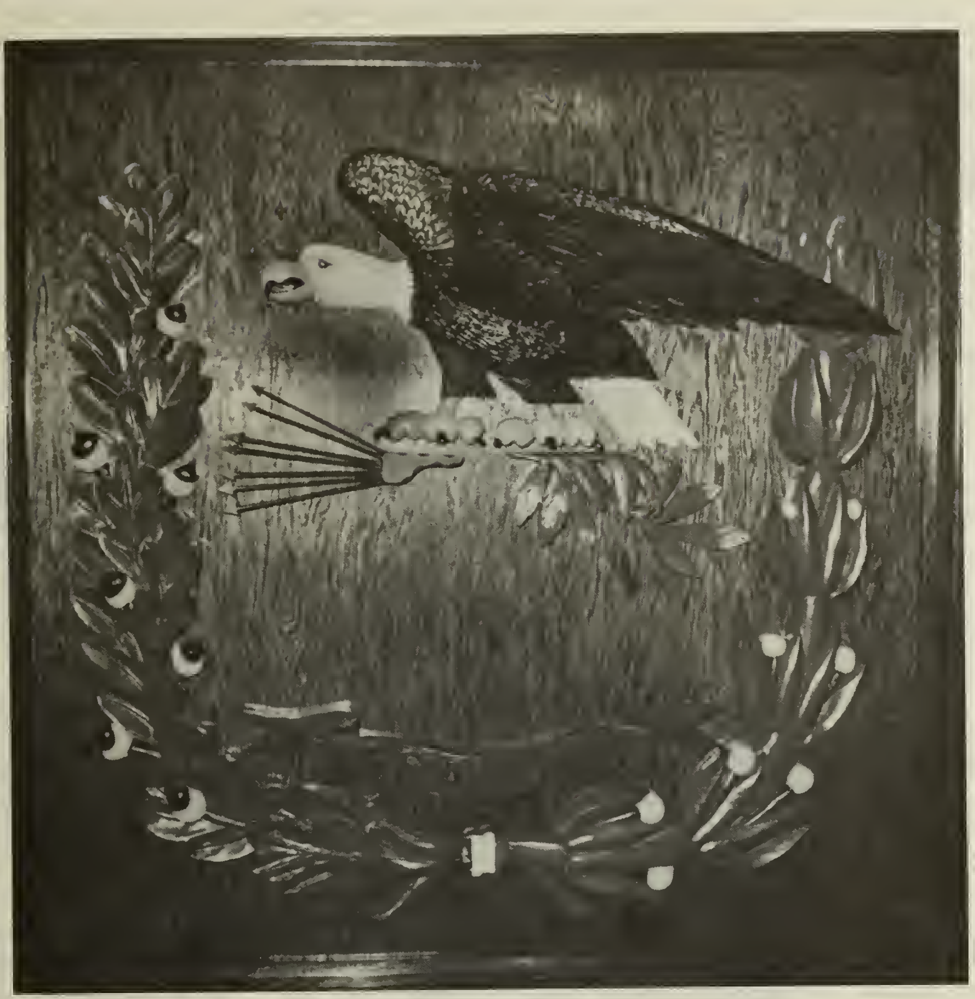
Here's a health to the Army,
And here's a health to our Corps;
Here's to the Flag, flying up on the hill,
And the bird flying over our door:
Stand by, with your glasses all brimming,
Here's health, and here's how, and here's luck,
And here's to the Castles of Silver we wear,
And "the Eagle that looks like a Duck."

Sherwood A. Cheney
Brig Gen U.S.A. Retired

The line "Here's to the Flag flying up on the hill" referred to the American flag that flew in front of the Post Headquarters, which was situated on a prominent hill at Willets Point. The line "And here's to the Castles of Silver we wear" referred to the engineer insignia. Prior to 1924 the insignia was silver, not gold. The references to "the bird flying over door" and "the Eagle that looks like a Duck" referred to a relief carving of the crest taken from the seal of the Corps of Engineers.

The crest consisted of an eagle mounted above a banner and inscribed with the engineer motto "ESSAYONS." Surrounding the eagle and banner was a wreath of oak and laurel branches, oak symbolizing strength and laurel symbolizing accomplishment. They were mounted on a large wooden plaque that hung above the door to the main dining room in the Willets Point officers mess.

The "Eagle that looks like a Duck" hung in the officers mess of the Engineer School at Willets Point from some time after 1866 until just after the turn of the century. With the transfer of the Engineer School from Willets Point to Washington Barracks (now Fort McNair) in 1901, the eagle moved to the Washington Barracks Officers Club. When the Engineer School moved to Camp A. A.



Humphreys (now Fort Belvoir) in 1918, the eagle plaque was hung in Harris Hall, the original officers club. In 1935 Mackenzie Hall was built as the "new" club, and the eagle moved to the second floor Castle Room. She hung there, high above the fireplace, on the south wall until 1988. When the Engineer School moved to Fort Leonard Wood last year, the eagle came west for the first time in her long history.

The eagle was in dismal condition when she arrived at the U.S. Army Engineer Museum, Fort Leonard Wood. Mr. Donald Fisher, at the Training Aids Support Center (TASC), was given the task of restoring the bird and the plaque.

During the restoration, a handwritten paper tag was found on the reverse side of the plaque. The tag reads "REPAIRED BY SGT KRAUS - PVT RAKER, APRIL 1938. OTHER REPAIRS UNNONE" (sic). Another discovery was the name STENDER carved into the upper edge of the eagle's olive branch. Presumably he was the original artist.

Old repairs were re-repaired. When the smoke stained varnish was removed, the original brilliant colors were revealed, which over the years had discolored to a dingy brown. Four missing arrows were replaced in the eagles talons, and finally the entire backing and frame, remnants of Kraus and Raker's 1938 restoration, were replaced.

After undergoing this extensive conservation and treatment program to restore the original grandeur to this piece of Engineer School tradition, the eagle will be hung in the new Regimental Room in the U.S. Army Engineer Museum. The eagle will once again watch over Engineer School activities, as she has since before BG Cheney ignominiously referred to her in his toast as "the Eagle that looks like a Duck."

Robert K. Combs, curator of the U.S. Army Engineer Museum at Fort Leonard Wood, Missouri, is a graduate of San Francisco State University. He has an M.A. in museology from John F. Kennedy University. Mr. Combs has worked with the Smithsonian Institution, the San Francisco Fine Arts Museums, and the Presidio Army Museum in San Francisco before coming to Fort Leonard Wood in 1982.

EVOLUTION OF THE ENGINEER REGIMENT

by Dr. Larry Roberts

In February 1986, the Corps of Engineers joined the Army Regimental System. A short time before, General Wickham, Chief of Staff of the Army, had approved the organization of the engineer regiment to include the entire Corps of Engineers. This may be a new idea for young soldiers today, but the regimental system and the history of America's military engineers are older than the nation itself.

National governments and monarchs have organized their armies into regiments for centuries. In fact, the word regiment comes from a base word meaning "to rule." In the early days of the American Revolution, colonies and the Continental Congress organized their respective forces on the British regimental pattern. The colonists borrowed heavily from their British adversaries. Rank structures, command arrangements, and some special staff positions were similar.

From the beginning of the struggle with mother England, there was a recognized need for an engineer element in the colonial force. The Continental Congress provided for one chief engineer and two assistants in 1775, almost a year before the Declaration of Independence. Congress established the Corps of Engineers four years later.

Trained engineers were scarce in the colonies. The first Chief Engineer, Richard Gridley, was a former British officer with considerable experience. In addition, many French officers, using the training and experience they had gained in Europe, served as engineers in the Continental Army.

In establishing the "Corps," Congress used the term in its most basic form. The corps, as a tactical unit, did not appear until the Napoleonic wars early in the 1800s. As applied to the engineers and later to the quartermasters, ordnance officers, and signalmen, the word corps meant a body of individuals with a unique specialty. For the next 70 years, the Corps of Engineers consisted primarily of officers. Congress did not include enlisted engineers in the Army until the Mexican War.

During the American Revolution, the histories of the engineers and the artillery were intertwined. Commanders and civilian leaders perceived both services to be very technical in nature. Both were involved in battle during the establishment or attack of fortifications. Both relied on mathematics and the sciences as their base educational disciplines. These similarities prompted Congress to place the two branches in the same corps for a short time after the Revolution. Lieutenant Colonel Stephen Rochefontaine was the Commandant of the Corps of Artillerists and Engineers from 1795 to 1798. His successor, Henry Burbeck, commanded the corps until the two branches separated in 1802.

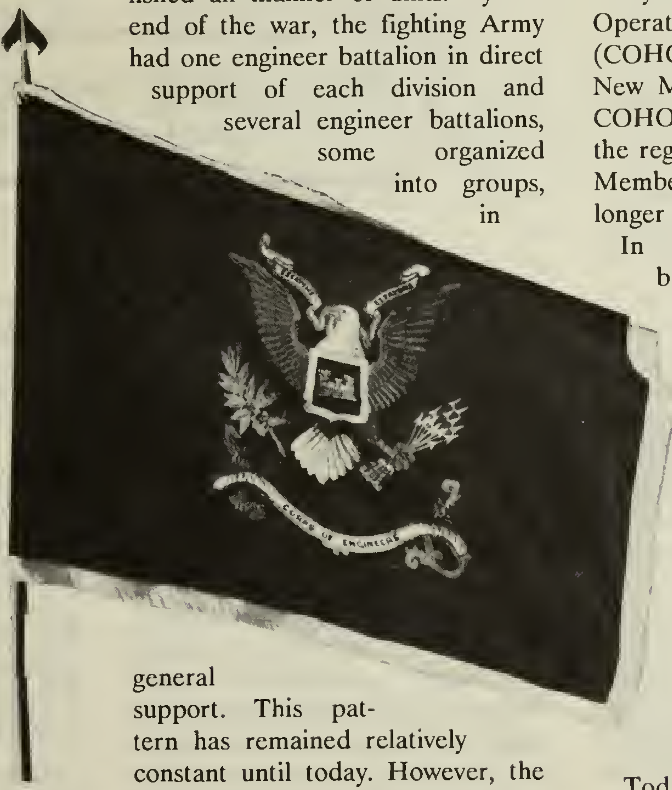
In the following decades, the Army organized numerous cavalry, infantry, and artillery regiments. The Corps of Engineers remained primarily a collection of officers performing various services to the country. The most significant change during this period was the creation of the topographical engineers, first as part of the Corps, later as a separate bureau, and finally again part of the Corps. The major distinction between the "Topogs," as they were called, and the Corps engineers was the orientation of their work. The Corps concentrated on fortifications and other military engineering. Topographical engineers were involved with civil works projects that opened the American West to settlement and improved transportation and commerce.

When the Civil War erupted in 1861, the Regular Army engineer establishment was enlarged. Congress increased the number of engineer companies to three and formed them into a battalion. Regiment-sized engineer units existed mainly in the volunteer and militia units formed by the states. Much of the engineer work done during the Civil War was performed by these citizen soldiers. For example, a Michigan regiment of "engineers and mechanics" supported Union forces during the battle of Chickamauga. The Union forces also had the services of a Missouri Pioneer Brigade during the same campaign. Pioneer troops usually were organized with the infantry, but they performed basic engineer duties.

Between the Civil War and World War I, the engineer establishment remained comparatively small. Engineers continued to work on coastal fortifications and civil works projects, such as harbors, rivers, and roads. Congress expanded the Corps in 1901, and converted each company of the engineer battalion to individual battalions. For the Army as a whole, the battalion and regiment were the principal tactical organizations. In fact, prior to 1912, the Army did not have a tactical division. Years of existence at small, scattered frontier garrisons prevented the service from developing a divisional structure until the eve of World War I.

In 1916, fearing involvement in the European conflict, Congress altered the size and composition of the U.S. Army. Among their actions was an expansion of the Corps—the engineer battalions were expanded to regiments. During World War I, Army engineers in Europe handled everything from harbor construction to combat duties in the trenches. Their experiences generally set the pattern for the second world conflict two decades later.

World War II brought significant change to the engineer force structure. The War Department established, deactivated, and re-established all manner of units. By the end of the war, the fighting Army had one engineer battalion in direct support of each division and several engineer battalions, some organized into groups, in general support. This pattern has remained relatively constant until today. However, the idea of "the regiment" never died.



In 1957, the Secretary of the Army approved the Combat Arms Regimental System (CARS). The purpose of CARS was to improve the efficiency and morale of our fighting forces by stimulating pride in the unit to which soldiers belonged. The past achievements of that unit and its traditions were the basis for that pride. The CARS approach attempted to perpetuate the heritage of the regiment primarily for the combat arms, even though the battle group and battalion had replaced the regiments as the basic tactical units.

Now, 25 years later, the Army is again advancing the regimental idea. The reasons are basically the same as those prompting CARS. The regiment today exists to promote combat effectiveness. It provides an opportunity for affiliation, enhances the development of loyalty and commitment, and fosters an extended sense of belonging. The regiment improves unit esprit and institutionalizes the warfighting ethos.

Initially, the Army's new regimental system was tied to the Cohesion Operations Readiness and Training (COHORT) program as part of the New Manning System. The link to COHORT has been broken, and the regiments are now independent. Membership in a regiment is no longer tied to assignments.

In developing the regiments, branches were given several options. They could establish one regiment for the whole branch, functionally structured organizations, or regional regiments. Most of the combat arms decided to organize several regiments. The leadership of the Corps of Engineers, believing that the principle traditions of the engineers were at the battalion and with the Corps, decided on a single regiment.

Today, every soldier who wears the castles of the engineers can become a member of the regiment. In the single regiment are the customs, traditions, and heritage of countless thousands of engineers who have come before us. The history of the Corps of Engineers, which spans two centuries, is now the history of the Engineer Regiment.

Dr. Larry Roberts is the historian for the U.S. Army Engineer School and Center, Fort Leonard Wood, MO. He received a Ph.D. in history from South Dakota State University in 1981.

Overseeing engineer career management fields

The force is now at its lowest level since 1950.

by SFC Donald Eelman and SFC Jose Guzman

The Army's continuing force reduction means that a limited enlisted force must be structured to support all mission requirements. At the same time, we must provide the soldier adequate career progression from entry level to sergeant major. The force is now at its lowest level since 1950.

The Engineer Personnel Proponent Office (EPPO) oversees engineer career fields. Our recommendations create initiatives that ultimately affect engineer soldiers. EPPO's areas of responsibility, outlined in AR 600-3, include—

- Force Structure
- Acquisition
- Individual Training and Evaluation
- Distribution
- Unit Deployment
- Sustainment
- Professional Development
- Separation

The engineer enlisted force is made up of more than 28,000 soldiers structured into three career management fields (CMF): CMF 12 (Combat Engineering), CMF 51 (General Engineering), and CMF 81 (Topographic Engineering). By definition, each CMF is to consist of a manageable grouping of related Military Occupational Specialties (MOS) and provide a visible and logical progression, from the entry level soldier to grade E9.

Congressional and Department of Defense (DOD) constraints present challenges for EPPO in providing a viable, logical, and adequate career progression for engineer soldiers. Such constraints include budget and manpower limitations. For example, Congress has mandated that E9s must not exceed 1 percent, and E8s and E9s combined must not exceed 3 percent of the active enlisted force.

If a CMF restructure or MOS revision causes an increase in the grade structure, a "billpayer" or tradeoff of the same grade must be identified by the proponent. In other words, if MOS 51B is increased by 50 authorizations at grade E5, 50 authorizations at grade E5 must be reduced elsewhere in the engineer enlisted force. This "zero sum gain" policy is a major element contributing to the approval of a Military Occupational Classification Structure (MOCS) action.

CMF 51, the most diverse engineer field, contains 19 MOSs, which are divided into subfields—

- Technical Engineering
- Power Engineering
- Vertical Construction Engineering
- Horizontal Construction Engineering
- Specialty Engineering (Firefighting, Diving)

The career goal for soldiers in CMF 51 is to progress to grades E8 and E9 in MOS 51Z (General Engineering Supervisor).

Progressing to these senior noncommissioned officer grades is a challenge to all CMF 51 soldiers. Department of the Army criteria state only the "best qualified" will be selected for promotion, making progression into the low number of senior noncommissioned officer authorizations in CMF 51 extremely competitive. Each MOS in CMF 51 has specific and unique force structure concerns that must be monitored constantly to improve their force structure design.

Significant actions

The EPPO has recently completed some actions and is currently working on others that will affect soldiers in CMF 51.

Revisions

- MOS 00B (Diver) has been revised. The Office of the Deputy Chief of Staff for Personnel (ODCSPER) has approved a change to retain senior enlisted diving expertise. This change provides Army divers with career progression to master sergeant (MOS 00B50). Five positions were created from MOS 51Z authorizations. Improvements in diving safety, personnel management, validation of qualified personnel, and retention of technical expertise are expected in the diving community as a result of this change.

- ASI C7 (Survey Instrument Repairs Specialist) was created to include tasks from MOS 41B (Topographic Instrument Repair Specialist). MOS 41B was eliminated from the Army force structure in March 1989 due to low density in personnel and lack of repair parts at the intermediate maintenance level. Tasks associated with this MOS were transferred by way of the additional skill identifier (ASI) to MOS 82B (Construction Surveyor) and MOS 82D (Topographic Surveyor).

Soldiers holding these specialties, whose positions are recoded with ASI C7, will attend the survey instrument repair course at the Defense Mapping School. The number of authorizations for the ASI holding specialties will not increase.

Proposals

- MOS 52G (Transmission and Distribution Specialist) may be consolidated with MOS 52E (Prime Power Production Specialist). In 1987, the Engineer School analyzed the MOS 52G mission requirements in the Active and Reserve Components (AC/RC). Findings showed that the MOS was becoming grade infeasible; there was no progression to senior grades. By FY 1990, MOS 52G authorizations in the AC would be reduced to 18 positions.

The Engineer School made a proposal to transfer duties and responsibilities from MOS 52G in the AC to MOS 52E by way of an ASI. MOS 52G will be retained in the RC to maintain adequate mobilization capabilities. The recommended MOCS change has been submitted to Soldier Support Center, National Capital Region (SSCNCR) for worldwide staffing. The change is at the ODCSPER awaiting approval.

- Because of low densities, several technical engineering specialties may be consolidated into a single MOS structure. MOS 51G (Materials Quality Specialist), 81B (Technical Drafting Specialist), 82B (Construction Surveyor), and 51T (Technical Engineering Supervisor) are recommended for consolidation. Progression in MOS 51G is no longer feasible.

The restructured MOS will combine the skills of the surveyor, draftsman, and materials tester. A technical engineering specialist (MOS 51T10) is proposed as an initial entry occupational identifier. To ensure the soldier and engineer unit are enhanced by this change, critical tasks, training strategy, cost, soldier assignment, and use-impact data are being collected for analysis.

- The Engineer School will resubmit a proposal this summer to SSCNCR that documents existing MOS 51Z authorizations. This action provides eight additional duty position titles. They account for positions in MOS 51Z that are not addressed in AR 611-201. It does not increase the number of authorizations for MOS 51Z.

- Actions are underway to improve our well drilling capabilities (ASI C3). A proposal was submitted to SSCNCR to disassociate MOS 62J (General Construction Equipment Operator) skill level one soldiers with ASI C3. The U.S. Navy Training Center, Port Hueneme, California, conducts the well drilling training, and only NCOs are accepted in their course.

A well drilling L series Table of Organization and Equipment (TOE), developed by the Engineer School, provides a two shift/24-hour concept of operation. A construction equipment supervisor (62N30C3) is authorized for each shift to provide expertise and supervision in well drilling operations. One construction equipment repairer (62B10) is also authorized per team. A proposal to include a construction equipment supervisor (62N40) to each well drilling team is being considered, provided billpayers are identified.

The outlook is for a tighter budget and additional force structure cuts. EPPO will continue to oversee engineer CMFs during this stringent time. Our goal is to improve the career progression opportunities of the most valuable soldiers on the battlefield, the engineers.

SFC Donald Eelman is a general engineering proponent coordinator with the Engineer Personnel Proponent Office, Fort Leonard Wood.

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the Soviet Engineer in tactical operations

by LTC Roger J. Somerville

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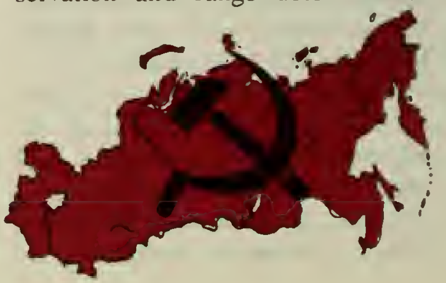
No discussion of tactical Soviet combat operations is complete without addressing the myriad of combat and combat support roles played by all the elements of the force. While armor and infantry forces often take the center stage in Soviet ground operations, artillery, NBC, engineer and a great number of support capabilities will certainly influence the outcome. Some even say it is these other capabilities which give the maneuver arms the opportunity to do battle in the first place, and none more so than the combat engineers. This article will cover the Soviet engineer and his contribution to the battle. We will see how critical his mobility, countermobility, and survivability support can be, and how we must deal with him to reduce his effectiveness. For just as certainly as the sun will rise tomorrow morning, the Soviet engineer will do all he is trained to do to enable his maneuver arms comrades to close with and engage our forces in the next conflict.

To fully understand the Soviet combat engineer, one must read Soviet military history, which is beyond the scope of this article. However, by understanding how he is organized for combat, we will see how we can defeat him. This does not mean you will be seeing wiring diagrams and miscellaneous organizational charts for the rest of this discussion. Rather, we will take a look at some of the component organizations of Soviet combat engineers, what they do, and why they are part of the picture. This "understand his organization" approach will enable you to anticipate, identify, and neutralize the combat engineer forces and prevent them from accomplishing their missions.

ENGINEER RECONNAISSANCE PLATOON

The Soviets are acutely aware of the need for engineer intelligence to assist in maintaining a rapid rate of advance. The principles of Soviet reconnaissance are aggressiveness, continuity, timeliness, reliability and accuracy. The reconnaissance resources in the motorized rifle and tank division's combat engineer battalion are the engineer experts in this area. They will be used in recon detachments from division to regimental levels to assist in accomplishing these principles.

The Engineer Reconnaissance Platoon (IRD) is a separate unit of the divisional combat engineer battalion, under the command of an experienced officer. The platoon is transported on the battlefield in BRDM scout cars or BTR 50/60 armored personnel carriers. Engineer recon patrols can also operate in helicopters, on motorcycles, or on foot. They are equipped with observation and range determination



devices, equipment for reconnoitering mixed minefields, measuring cables and tapes for reconnoitering water obstacles, writing equipment, and other sapper tools. In the Soviet divisions, the engineer recon platoon could be deployed with the division recon battalion, as squads with parts of the recon battalion, with any of the regimental recon companies, or separately.

The IRD is organized according to the situation and assigned missions. It could consist of squad size elements or up to a platoon of engineer recon troops and at times includes one or more chemical warfare (CW) scouts. To reconnoiter especially important objectives and get more precise technical information on the enemy and terrain, the IRD will be commanded by the engineer platoon leader.

The IRD has the mission to determine the following:

- Obstacles to be overcome.
- Engineer equipment required to accomplish the mission.
- Location and quantity of material which can be used to improve the march route.
- Nature of the terrain and the location of areas that do not afford natural concealment.

The IRD missions will include:

- Detecting enemy engineer efforts to prepare occupied positions and strongpoints, setting up minefields, and demolition work.
- Determining the condition of roads and bridges.
- Determining the location of local building materials and water supply locations.
- Determining protective and camouflage terrain properties.
- An IRD can observe, raid, carry out direct examination, and photograph objective areas.

This engineer reconnaissance provides information to the regimental commander about assembly areas, detours around obstacles, and warning of minefields and craters. The patrol carries the equipment required to find obstacles and mark their location or bypasses. They can provide breaching assets forward at key choke points and have route marking flags to assist the movement of the main attack of the regiment.

The engineers supporting the 32d Guards Motorized Rifle Regiment (GMRR), the OPFOR, provide a mechanized engineer squad mounted in a visually modified M113 (which looks like a BMP), MTLB, or BTR 50 to the Recon Company for reconnaissance prior to regimental or division attacks. This squad is led by a Ranger or Sapper-qualified, NTC-experienced lieutenant or staff sergeant who understands patrolling, security, navigation, and actions at the objective area. The OPFOR recon company and IRD provide important route and obstacle information to the Chief of Intelligence, which helps him recommend a course of action to the Regimental Commander.

MOBILE OBSTACLE DETACHMENT (POZ)

To accomplish the mission of rapid laying of mines and placement of obstacles, a special team called the Mobile Obstacle Detachment (POZ) is formed from regimental and divisional engineer assets. The POZ will place antitank mines on the most likely avenues for armored attacks or counterattacks. Additionally, they are equipped to crater roads or destroy bridges along these routes. POZs are positioned on the flanks of a march formation for rapid deployment and are normally in close proximity to the antitank reserves. During the march they reconnoiter the avenues into the flanks for suitability and identify the most likely avenues for tank movement. At the secured objective the POZ will reinforce the existing obstacles and place new obstacles to help defeat any counterattack. The composition of a POZ depends on the combat situation, troops available, and is organized by order of the combined arms commander. The engineer elements in a division POZ come from the divisional engineer battalion and consist of three armored tracked mechanical minelayer vehicles (GMZ). This platoon sized element will have two to three trucks carrying mines for immediate resupply. For the regimental POZ, the regimental engineer company can provide a platoon sized unit which is equipped with two or three mine laying trucks pulling the PMR-3 mechanical minelaying trailer. This platoon would travel in their BTR-50/60, have 600 antitank mines and 200 kilograms of explosive. Both systems dispense surface-laid TM-62 antitank mines at a predetermined spacing of 4 to 5.5 meters. Mine-laying helicopters can also be employed and they dispense mines from a chute while flying at a height of about 5 meters. Artillery fired FASCAM could also support the POZ.

In the 32d GMRR, the divisional POZ assets are replicated by VISMOD M113s that have soldiers dispensing mines out the back door or from the back of a trailer as the vehicle travels cross country. Each M113 will carry 150-200 AT mines to have the same capability as the GMZ. The vehicle has a four man crew consisting of a track commander, driver, soldier arming the mines, and soldier placing mines on the ground. The mines would be placed 4 to 6 meters apart with 3 rows placed 30 to 40 meters apart. The division POZ could lay 1000 meters of minefield in approximately 30 minutes. In the future a BTR-50 or MTLB could be VISMODed to look like the GMZ. The regimental POZ assets are currently replicated by VISMOD M113s and could be replicated by 2 1/2 or 5 ton dump or cargo trucks that have a mine chute attached on the side. The mine capacity is the same as the divisional POZ.

The OPFOR minefields placed by the POZs are covered by antitank reserves from the antitank company equipped with AT-5s. The minefields are placed 500 to 1200 meters in front of the AT-5 positions. They are placed with 3 rows spaced 30 to 40 meters apart, giving them a depth of 80 meters and are usually 200 to 300 meters long. The minefield intent is to disrupt the command and control of the attacking force. The POZ has enough mines to emplace 4 to 5 minefields.

MOVEMENT SUPPORT DETACHMENT (OOD)

A Movement Support Detachment (OOD) is created from organic or attached engineer units by the combined arms commander before a march to provide direct engineer support to the routes of movement. The OOD guarantees mobility along the main route, timely passage of phase and deployment lines, and also assists the maneuver forces deploy into battle positions in accordance with combat arms operations. An OOD is task organized from divisional and regimental engineer assets with support from infantry squad(s), based on the mission and availability of troops. The OOD will be from platoon to company strength and is equipped with special route and mine clearing vehicles and equipment.

The OOD can fill craters, clear mines and obstacles, prepare bypasses around major obstructions, and identify contaminated areas. The composition and equipment of an OOD depends on the terrain conditions, the nature of the enemy operations, the volume of tasks at hand, the assigned column speed, and on the availability of engineer forces and equipment. An OOD usually includes a reconnaissance and mine clearing group, one or two road and bridge repair and construction groups, and a route marking group. The OOD can be allocated combat arms subunits to provide security and may have chemical scouts to determine the radiation level in the terrain. Two variants of the OOD's organization are shown on page 41.

The OOD usually moves in advance of the main body with an advance guard or forward security element (FSE) and in some cases with a combat reconnaissance patrol (CRP). With information provided by the chiefs of intelligence and operations, the OOD reconnoiters and marks the routes on the terrain, breaches and marks crossings in the obstacles, determines the type destruction on the line of march, searches for and marks the detours, and scouts for engineer construction materials.

The divisional engineer battalion can form two or three OODs. These OODs are employed on the divisional main routes and are always under the protection of an advance guard or forward security element. On other routes, the leading regiments provide OODs from their organic engineer companies. A common OOD at this level would consist of up to an engineer platoon with the BAT-2M dozers or up to three tanks fitted with the BTU

875th Combat Engineer Battalion (ARK NG) sappers placing pickets for a Lucias double concertina wire fence. Note they use two two-man picket pounding teams.

MOVEMENT SUPPORT DETACHMENT (OOD) VARIANTS

Variant I

RECON OBST DEST GROUP
Tank w/mine plow
CBT ENG SQD
Bridge-laying vehicle
Chem Dosimetrists

ROAD BRIDGE GROUP
Truck launched bridge
Tracked dozer
ENG Bridge SQD
MRP(-)

ROUTE MARKING GROUP
MRP w/marking equipment

Variant 2

RECON OBST DEST GROUP
Tank w/mine plow
CBT ENG SQD
Bridge-laying tank
Chem Dosimetrists

ROAD GROUP
Tractor dozer
CBT ENG SQD(-)

BRIDGE GROUP
Truck launched bridge
MRP(-)

ROUTE MARKING GROUP
MTR Rifle SQD
CBT ENG SQD
w/marking equipment

dozer blades. These OODs are protected by up to a platoon of infantry or tanks and can be accompanied by chemical reconnaissance personnel.

The combat engineer sapper platoon in the OOD is equipped for breaching. The division OODs come from the combat engineer company in the divisional engineer battalion and have two of these sapper platoons and a mine layer platoon. The mine layer platoon provides the personnel and equipment for the POZ, as discussed earlier. The two sapper platoons are organized with a mine detection section, mine clearing section, an armored engineer tractor (IMR) section, and a sapper section. To find the mines, it contains a light wheeled vehicle with the metallic mine detector mounted on the front (DIM w/IMP). The other three sections have the capability of making multiple breaches in complex obstacles. The UR-67 is a BTR-50 chassis that carries a line charge which can clear a lane 180 meters deep and 6 to 8 meters wide. The IMR has the capability to clear lanes 3.4 meters wide. The sapper squad will manually breach other lanes with explosives and engineer tools. The UR-67 and IMR can breach FASCAM. The regimental OOD is not equipped with these special engineer vehicles but has the MTU-20 tank launch bridge and is formed around the combat engineer platoon from the regimental engineer company. This company has available the BTU dozer blades and the KMT-4 mine clearing plows or KMT-5M mine roller-plows, all for mounting on the regimental tanks.

The OODs in the 32d GMRR are employed on the main route of march under the protection of a CRP, FSE, or advance guard. The regimental Chief of Engineer Services (CES) could receive one divisional OOD to deploy with the regimental OOD. These OODs are employed in the lead of the first echelon motorized rifle battalions to provide in-stride breaching capabilities to the OPFOR. These OODs have a secondary mission of always marking the bypasses or breaches for the second echelon battalion and follow-on forces. The OPFOR's OODs will have the current version of the Counter Obstacle Vehicle (COV) to replicate the IMR. The UR-67 is replicated by a VISMOD M548. VISMOD mineplows are mounted on one tank in each tank platoon. Using the Soviet organization, the OPFOR is an excellent breaching force and has excellent mobility on the battlefield.

OPERATIONAL NORMS FOR OBSTACLES

If the Soviet forces have to go into a defense, they will do so quickly and in a very organized manner. With the amount of engineer digging equipment available and integral blades on their tanks, in less than a day they can dig themselves in and have obstacles to their front. In offensive planning the S2 and S3 must gather a lot of information prior to attacking this force. From Soviet doctrine, operational norms for obstacles can be developed. Using these norms, the engineer working with the S2 and S3 can determine where the obstacles will likely be employed in the defense and offense. This will help the maneuver commander task organize his force to overcome these obstacles.

- METT-T is used in offensive and defensive planning operations.
- The Motorized Rifle Company Commander's obstacle concern is for self protection. The protective obstacles would be placed out 50 to 500 meters from the defensive positions.
- The Motorized Rifle Battalion Commander's obstacle concern is for the flanks of subunits and the MRB, and to shape the fire sacks. (Using sound military judgment, obstacles are placed out about half the effective range of the AT weapon systems.)
- The Combat Outpost Commander's obstacle concern is to look like an MRB and to support the mission to delay and disrupt the enemy. This is the first place you see obstacles. (Using sound military judgment, obstacles are placed to allow the unit to withdraw and would be placed out about two-thirds the effective range of the AT weapon systems.)
- Obstacle type is determined by who emplaces the obstacle. Maneuver and artillery soldiers install simple single system obstacles, which are usually protective. Engineer soldiers install complex obstacles that can have antihandling systems. Engineer obstacle placement is usually equipment intensive and can have a mix of AP and AT mines and wire.
- In contact with the enemy, the maneuver soldiers do little obstacle emplacement. Most all obstacles are placed by engineers and therefore are placed with equipment and are complex.
- With no enemy contact, infantry, armor, artillery, and engineer soldiers emplace obstacles.
- The priority for nonexplosive obstacles is first to protect the force, then forward in the fire sacks. Wire obstacles are used to protect the flanks and support the explosive obstacles.
- The friendly side of obstacles are marked.
- Deception survivability positions and obstacles will be planned.
- Soviet graphics are very specific and will be followed closely.
- The obstacle priorities are:
  - -Protection:
    - Flanks.
    - Seams between units.
    - Front of positions.
  - -Tactical: Shape of fire sacks.

As we hope this article has shown, the Soviet (OPFOR) commander depends on his combat engineer soldiers to give him mobility, countermobility and survivability. He has equipped his engineers with specially designed equipment to accomplish these tasks. (The Soviet bridging assets were not covered because this equipment is not currently used at the NTC.) It is therefore important to the U.S. maneuver commanders to identify these elements early on and then destroy or neutralize them. By destroying the enemy's engineer support, you deny him an extremely valuable combat multiplier and at the same time drastically reduce his mobility. This shatters his rigid timing and synchronization, allowing our own forces to engage and destroy him at our choosing, not his.

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(Past in Review, continued from page 49)

clears the road ahead with a mine detector.

American engineers served, fought, and died in every theater of operation in World War II. From Iceland to Burma, from Alaska to Europe and beyond, engineers planned, built, destroyed, and rebuilt their way around the globe. The World War II interpretation ends with an original "fat man" atomic bomb. This artifact represents the most important engineer project of the war.

Turning right, you will see the destructive capacity of the engineers as they withdrew to the Pusan Perimeter in the fall of 1950. The Korean conflict will merge into another cold war confrontation in the southeast Asian country of Vietnam. In the Vietnam exhibit, you will walk past a command post of a Delta fire base. In front of the sandbag-covered walls is a rare Jeep-mounted electronic mine detector. Using this and other objects of the conflict, you see the classic clash of cultures: American industrial high technology versus indigenous Viet Cong low technology.

Moving past Vietnam, you will pass through a corridor dedicated to engineer heroes. The walls are lined with photographs and material from such a diverse lot as Robert E. Lee, Corporal Terry Kawamura, Sergeant George Libby, and Thaddeus Kosciuszko. At the end of this hall of heroes stands a modern combat engineer in full battle dress, a reminder that the memory of the heroes and history of the past depend on the men and women of the present.

Now you have completed a tour of the first phase of the U.S. Army Engineer Museum, Fort Leonard Wood. An additional 27,000 square feet of space will be ready for occupation in July 1991. This is just the beginning.

(biography on page 33)

RISK MANAGEMENT

a key to training safely

by Dean Johnson

Today's Army uses high-tech equipment that is complex, expensive, and easily damaged. The risk of losing this equipment or making a mistake with it due to human error can jeopardize a mission. While Army leaders traditionally consider risks imposed by the enemy when planning missions, they must also consider risks imposed by our own actions.

Army leaders must be smart decision makers. If we are to engage the enemy, we must reach our objective and sustain the battle. Accidents that damage modern sophisticated equipment may destroy our mission capability before the enemy is engaged. The loss of a tank, bridge vehicle, or other critical equipment may mean the difference between victory and defeat.

Risk management is a tool smart decision makers use to make more effective decisions. Risk management is a process used to assess the risks, decide which are necessary, and reduce or eliminate unnecessary ones.

There is no difference between this process and a good leadership process. Good leadership considers safety a critical element of mission success. To be successful, a mission must be accomplished at maximum efficiency with minimum cost or losses. Every man or piece of equipment lost, and all time lost due to accidents or equipment failure, detract from mission efficiency.

A key to efficient mission accomplishment is good risk management. This includes safety, the resources needed to accomplish the mission, and the use of those resources.

Training missions must be accomplished in a realistic manner. By the same token, our high-tech, expensive equipment is not easily replaced and must be conserved. Thus, improved risk management

Accidents that damage modern sophisticated equipment may destroy our mission capability before the enemy is engaged.

The loss of a tank, bridge vehicle, or other critical equipment may mean the difference between victory and defeat.

techniques are needed to increase the realism in training while effectively using our resources.

These resources include manpower, materials, equipment, and the environment.

When planning an operation, consider each resource and the effects the operation will have on it. Ask questions: Do we have adequate manpower, equipment, and materials to perform the operation? What effect will the environment have on the operation?

If the environment seems unimportant to you, think back to the Normandy invasion in World War II. The decision to invade was based on weather conditions. Allied forces took a considerable risk, but the alternatives warranted a high risk because the potential gain was great. Other environmental factors important in the decision-making process at Normandy were shore, tide, and wave conditions. Tide levels affected our ability to land, based on the shoreline, and high waves might have made off-loading impossible.

Two points are significant:

- The balance of benefit to be gained at the cost of resources expended should be the least we will accept; and
- The environment, often the least considered risk factor, may be critical to an operation's success.

After risks are identified, a smart decision maker uses them to decide which are essential, which can be eliminated, and which can be controlled. Risks are used to determine alternatives and make quality decisions based on the benefits to be derived from the operation. Information on accident risks and tactical risks, as part of the operation, is included in the operation plan, lesson plan, LOI, etc. Safety aspects are integrated into the operation where they are appropriate. They are not relegated to an annex or appendix, where they may be overlooked or ignored.

Risk management is beneficial. By integrating safety into the operational plan, the monitoring process is in sequence with the flow of the mission. The after-action report will provide information about successes, failures, and lessons learned. These will fall in a sequence that pinpoints where adjustments or changes are needed. For repetitive operations, such as those at a training facility, required improvements can be made immediately and others made when the situation changes. One-time or field tactical situations provide reference data useful when planning similar operations.

Risk assessment worksheets are a valuable tool for decision making in engineer operations. They are used because engineers rarely do the same operation under the same conditions twice. Worksheets are prepared by developing a formula that allows quick assessment of the built-in risks. The commander determines which elements are critical for a mission and assigns numerical values to them. The elements chosen depend on the unit or mission.

For example, a commander determines that mission complexity, soldier selection, soldier endurance, equipment, weather, and terrain are critical elements for a planned mission. These are rated between 1 and 5, 1 being optimal (low risk) conditions and 5 being minimal (high risk) conditions. Thus, specific guidance and in-depth preparation are optimum and are valued at 1. Minimal and vague instructions are poor and are valued at 4 or 5.

After all risks are assessed, they are totaled and applied to the following reference scale: A low risk or optimal area is anything 12 or less. A rating between 13 and 23 signifies an adequate or caution area, and values 24 or more are high risks. Smart leaders make decisions that are consistent with the level of risk and are at the lowest supervisory level possible.

An example will show how a risk assessment is made. An engineer unit is participating in a bridging operation at Fort Leonard Wood. You, the decision maker, are given plenty of lead time and clear, concise guidance. The mission risk factor, therefore, is 1 (optimum). The bridging operation takes place in slowly moving water with shorelines conducive to the work. Thus, the complexity risk factor is 2. Because the troops are MOS qualified and accustomed to bridging operations, the soldier selection risk factor is 1. The equipment, of average age, has just passed a major inspection with high grades. Thus, the equipment risk factor is 2. The operation is an 8-hour, daylight tactical problem,

The risk factor and bridge requirements can change quickly due to weather at the site or upstream.

which means the endurance risk factor is 2. Clear weather conditions are forecast, with temperatures in the mid-60s and winds less than 10 mph. A weather risk factor of 1 is assigned. Because streambanks are conducive to operational needs, water depth is normal, and the water is clear, the water condition risk factor is 1.

The sum of these risk factors is 10, which means it is a low risk operation. Therefore, decisions about mission completion should be made by the site chief.

Let's change the conditions in this example. Heavy thunderstorms occur upstream the night before the operation begins. When the unit arrives at the site, the water level is nearly at flood stage. The muddy water is full of debris, and the current is swift. To complicate the situation, the weather forecast states that a fast moving front will hit around noon. High winds and thunderstorms are expected.

We must now re-evaluate the affected elements in the risk assessment. The mission risks will increase to at least 3. Mission complexity has changed drastically and is now rated at least 4. Unless the soldiers are trained for fast water operations and are experienced, their risk factor will increase. In this case, they are trained and have some experience, so the risk factor rises to 3. The equipment will be under more stress, which increases that figure to 3. The soldiers' endurance factor rises to 3 because work will be more difficult. The weather probably will affect work during the day, so that factor changes to 3. Due to the deep, fast, debris-laden water, the shoreline and working conditions jump to 5.

These changes compute to a total of 24, a high risk factor. Therefore, the decision on whether the training is worth the risk is made at the command level.

The method used to prepare a risk assessment depends on what you are assessing. This example, directed toward field training, can be used down to the lowest decision-making (squad) level. If this method does not fit your needs, ask your local safety office for assistance in developing alternatives.

The risk management process can be simple or technical, depending on the operation's complexity. Much depends on the way risk management is considered. If you think of risk management as a separate task in mission planning, the process probably will be difficult. If you think of risk management as part of the job, safety will be a byproduct of your professionalism.

Safety is a byproduct of professional leadership. It is not a product, it is an essential ingredient of a good product. Be a smart decision maker—train safely, not safely train!

Contact your branch safety office. We care and want to help. Call AV 581-7174 or (314) 368-7174.

Dean Johnson is a safety specialist at the Engineer Branch Safety Office and is a member of the World Safety Organization. Mr. Johnson has a B.A. in safety managment.

LESSONS LEARNED

The following lessons learned recently came to the attention of the Engineer School. They have been added to the lessons learned electronic data base maintained by the Directorate of Evaluation and Standardization (DOES).

M112 C4 block demolition charge

Issue: Dimension discrepancies for the M112 C4 block demolition charge.

Remarks: Not all M112 block demolition charges currently in use meet the dimensions given in FM 5-25, dated March 1986. The FM states that the dimensions for the M112 block demolition charges are 2 1/6" x 1/16" x 11 1/4." Random sampling revealed that some M112 blocks measure 2" x 1" x 10." The relative effectiveness (RE) factor of 1.34 and weight of one-quarter pound per block remain unchanged, according to the Director of Logistics. The validity of this is under investigation.

The volume of the larger M112 demolition blocks is 22 cubic inches, while the volume of the smaller blocks is 20 cubic inches. Users must recognize the 2 cubic-inch difference. Otherwise, calculations for ribbon and special purpose charges may be in error when the volume method is used to determine the amount of explosives required. Also, additional shoring materials may be needed during charge placement when using the smaller blocks.

Solution: To avoid calculation problems with the M112 demolition blocks, personnel should verify the block size before use. Measure a sample block from each case of C4. An example follows:

Ribbon charge example

Your mission is to cut an I-beam bridge. One I-beam measures 1 inch for web and flange thickness, 1 foot for flange width, and 8 feet for web height.

Using the volume method to calculate the ribbon charge, you need 3.99 blocks, rounded up to 4 blocks, of the large M112 explosive, with a volume of 22 cubic inches. For the small M112 explosive with a volume of 20 cubic inches, you need 4.39 blocks, rounded up to 5 blocks, of explosives to cut the same I-beam.

In this example, 25 percent more explosive is required to do the same job using the small M112 demolition blocks.

POC is CPT Ashcraft, Department of Military Engineering, AV 354-3411 or commercial (703) 664-6901/3411.

One third/two thirds rule

Issue: Adherence to the one third/two thirds planning rule.

Remarks: During an exercise at the National Training Center (NTC), the brigade staff mismanaged time by not having a structured or detailed wargaming plan. A plan should have been prepared during the first one-third of the time available but was not. As a result, units were unable to effectively conduct rehearsals or take the steps needed to adequately synchronize the battle.

Solution: Strictly enforce the one third/two thirds planning rule. Wargaming must be structured and detailed. Preparation and planning must be done as early as possible and result in a detailed and authoritative warning order. This ensures that units are able to effectively prepare for the upcoming battle or mission.

Engineer work priorities

Issue: Priorities for engineer missions and effort.

Remarks: During an exercise at NTC, the task force commander specified the priorities of effort for each phase of the exercise. During the defense phase, the engineer mission priorities were not specified. Brigade and task-force directed obstacles were not prioritized. Therefore, the task force engineer installed the obstacles as he saw fit. This resulted in a haphazard obstacle plan that did not reflect the task force commander's intent for the defense.

Solution: The task force engineer must be actively involved in the planning phase and clearly understand the commander's plan. The task force engineer must specify what can and cannot be accomplished and recommend priorities for the engineer missions and effort. If the task force commander fails to specify priorities in the operation order (OPORD), the task force engineer must be prepared to ask the right questions.

Mine laying operations

Issue: Lack of skill and experience accounts for many problems during mine operations.

Remarks: Problems surfaced when row minefields were installed. Leaders did not know how to correctly (IAW doctrine) emplace the minefields, so they could not properly supervise the mission. Perimeter markings were not used properly, and lanes were placed on roads.

Solution: It is a command responsibility to ensure subordinate leaders are technically and tactically proficient. Otherwise, leaders cannot effectively carry out their mission. Minefields must be marked and recorded. This is not left to the platoon leader's discretion. Unless there is no alternative, do not install minefield lanes on existing roads. When removing the lane markings, close the gap with mines to slow or prevent enemy passage.

Reserve demolitions

Issue: How to employ craters as reserve targets.

Remarks: An engineer unit executed a road crater between two antitank ditches as a reserve target. There was no demolition guard. The task force engineer decided not to prepare the demolition until all friendly vehicles had withdrawn across it. This violated the demolition orders, and the demolition was not at state 1 when required. Thus, when ordered to detonate, the charges were just being put in the ground. The firing party was killed on site and never completed the mission. Later, the demolitions were emplaced and the target was executed, but tracked and wheeled vehicles could easily drive through the resulting crater.

Solution: First, the demolition should have been emplaced early, as directed. Trenches for the detonating cord should have been dug (6 inches deep) prior to backfilling. U-shaped pickets should have been placed over the branch lines and ring mains for added protection. These efforts would have ensured that friendly vehicles did not damage the detonating cord.

Second, a report should have been sent to the task force commander letting him know the status of the obstacle's readiness. Code words are an efficient method of doing this, and they should be in the demolition firing order. Without this information, the maneuver commander operated in a vacuum.

Family of scatterable mines (FASCAM)

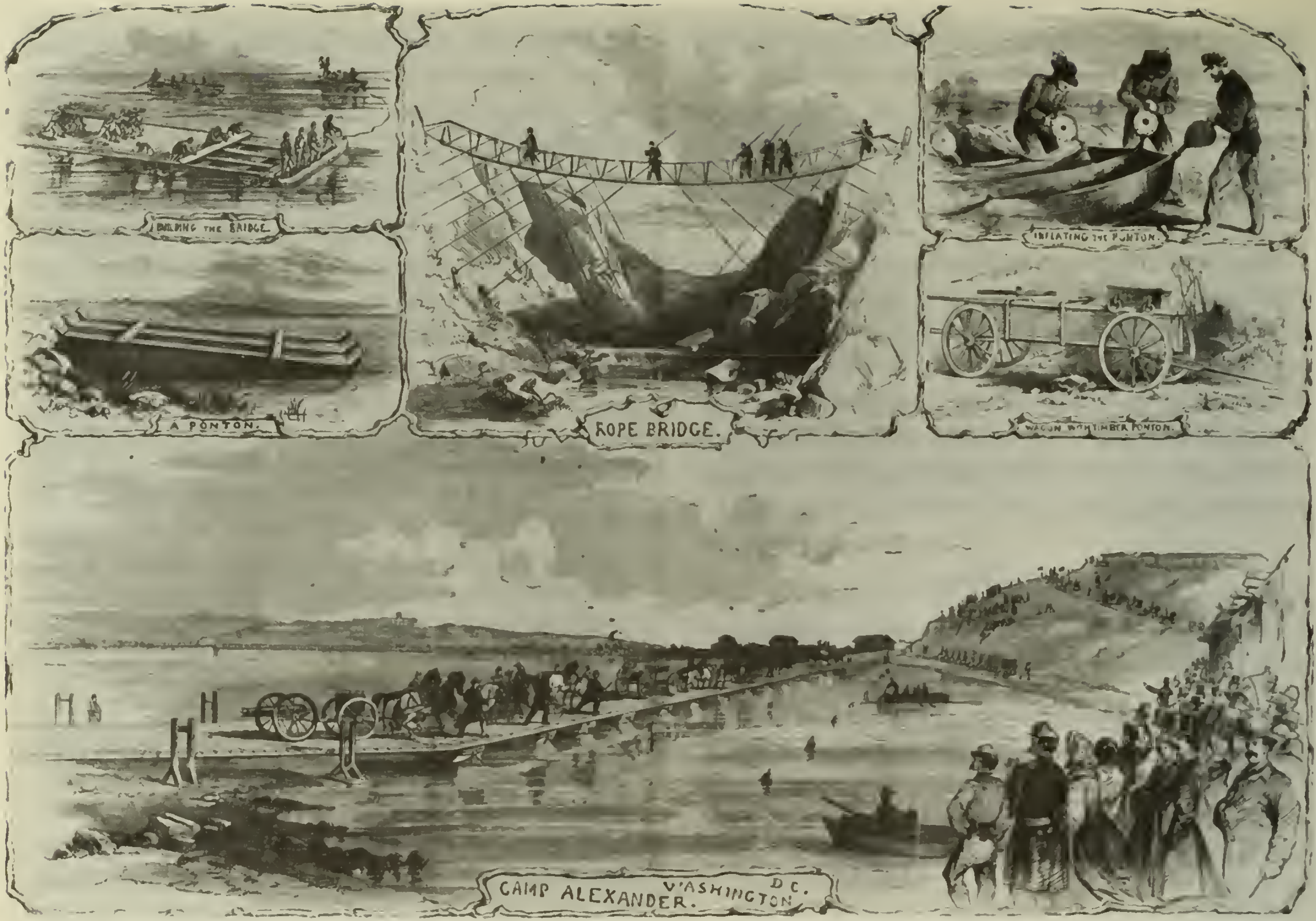
Issue: Inappropriate use of FASCAM.

Remarks: On one occasion, the FASCAM fire mission was late and, therefore, ineffective. In addition, the brigade S3, with input from the brigade engineer, planned other FASCAM missions that did not support the tactical plan. When the FASCAM rounds were fired, they effectively bracketed the brigade engineer units so they could not move.

Solution: Close, detailed coordination between the task force engineer and fire support officer is necessary. This will ensure that FASCAM is properly and effectively integrated into the tactical plan.

Lessons learned come from many sources, including the National Training Center and the Joint Readiness Training Center. After-action reports or lessons learned from all sources are welcome and needed. Call, write or forward reports to Directorate of Evaluation and Standardization, ATTN: ATSE-ESA, Fort Leonard Wood, Missouri 65473-6630.

Information is available from the data base. Forward requests to the above address. Please be as specific about your requests as possible.


BUILDING THE BRIDGE.
A PONTON.
ROPE BRIDGE.
INFLATING THE PONTON.
WAGON WITH TIMBER PONTON.
CAMP ALEXANDER. WASHINGTON D.C.

Since 1775, Army Engineers have built a proud heritage of accomplishments and have served the nation in both war and peace. The Civil War was no exception. In this drawing from the late 1880's, Union soldiers conduct experimental pontooning techniques and construct rope suspension and rubber pontoon bridges at Camp Alexander, near Washington, D.C. According to the original caption accompanying the drawing, General George B. McClellen and his staff were in attendance at the operations. The drawing originally appeared in one of a series of magazines entitled "The Soldiers In Our Civil War," published in 1884. The magazines were sponsored by the Grand Army of the Republic, a veterans' organization. The new U.S. Army Engineer Museum at Fort Leonard Wood, Missouri, scheduled for construction later this year, will include a similar Civil War scene in a diroama setting.

A Walk Through History

The history of U.S. Army engineers is an unbroken line spanning 214 years of war, peace, and accomplishment.

by Robert K. Combs

The history of U.S. Army engineers is an unbroken line spanning 214 years of war, peace, and accomplishment. Every Army engineer is responsible for keeping that important heritage alive. To preserve, document, and interpret the material culture (artifacts) from that unbroken line is a monumental task, and a new museum will be built to help accomplish this mission. Construction of the U.S. Army Engineer Museum, Fort Leonard Wood, will begin in December 1989.

The primary goal of the new museum is to support the Engineer Center and School, with a major emphasis on combat engineering. Civil works will be addressed as necessary to give a complete, rounded picture of the role military engineering has played in developing America. The new facility will also serve as the Regimental heritage center, in support of the Engineer Regimental Association. This organization is devoted to promoting the history and traditions of the Engineer Regiment.

The new U.S. Army Engineer Museum, Fort Leonard Wood, will begin with a 5,000 square foot gallery. In it, the engineer story will chronologically follow the unbroken line of engineer history, from the battle of Bunker Hill, to the training of today, and on into our future.

The museum will feature a new environmental display technique. Visitors will be immersed in an environment designed to evoke the feeling of the particular time period being interpreted. Instead of viewing glass cases containing rows of neatly arranged objects, visitors will encounter a scene or diorama in which artifacts are realistically displayed in a setting similar to that in which they were originally used.

Upon entering the museum, you will first notice the artifact maintenance and collection rooms that are visible on the left through floor-to-ceiling windows. Within these rooms the curator of the collections will maintain the thousands of artifacts in the museum's holding area. A highlighted seal of the Corps of Engineers will draw your attention forward until you are "in" the American Revolution. The texture of the floor changes to earth, and on your right a Continental engineer is hurriedly constructing fortifications on Breeds Hill. Tools, weapons, and period objects will be scattered throughout the diorama and arranged in subtle display cases on the right.

A forest of trees rises through the 14-foot ceiling ahead of you. The trees draw you past exhibits on the westward expansion of the early 19th century and the Mexican War. Following a path through the forest, you find another environment, that of the Civil War. Above your head on the right is the crest of Little Round Top. The date is 2 July 1864, and engineer general Gouverneur K. Warren is seen surveying terrain. Surrounding you is equipment used by engineers who fought the bloodiest war in American history.

Moving past exhibits on the Spanish-American War and through the locks of the Panama Canal, you descend into a World War I trench. The walls are corrugated tin, wood, and dirt. The musty smell of moist earth is apparent. Through period periscopes you can look into the hell known as no-man's-land. Relieved to be through the claustrophobic trench, you can use scale models to better understand the extent to which American engineers altered the battlefield with field fortifications.

After World War I, civil engineers altered the face of our nation with 20 years of construction. Projects such as buildings, dams, and riverways will be interpreted thorough photographs and didactic materials, bringing you to America's entrance into World War II. On your left is a diorama 12 feet high and 20 feet long. You are standing in a rubble-strewn street in the Italian port city of Anzio. A small D-4 bulldozer is straining to clear away the debris in front of several two-story homes and shops whose front walls have collapsed into the street. On the right an engineer

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dquarters, Department of the Army

November 1989

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TRAINING SAFETY

By Lieutenant Colonel Robert J. Greenwalt, Jr.

The Army has built an enormous safety edifice to ensure that we train safely, but we have missed the essential point—we must design our procedures and train our soldiers to be safe. The following conversation, a true story, illustrates what I mean:

The Commander asks, "Why can't we draw M-173 projected line charges for training at Hohenfels?"

The S-3 replies, "They have been designated restricted, war reserve only, because they are unreliable and unsafe for training."

Unreliable and unsafe? Use for war only? Why is it acceptable to use a munition when conducting a breach in combat that is too unreliable to use in training?

Every so often, an accident occurs in training. In response to tragedy, the Army examines itself to ensure that 'safety' is adequately emphasized. We give briefings, write safety into LOI and OPORDS, appoint safety officers and safety NCOs, restrict training to avoid known dangers, and investigate, investigate accidents. If too many accidents are associated with some training (such as swimming M113s), we stop the training. With all this, we haven't done anything to improve the safety of the force!

Many of today's safety programs promote peacetime risk avoidance, not safety. They either prohibit critical training or add an artificial step (such as rodding weapons on live fire ranges) that doesn't make sense for combat. We must change this. Safety is as important in combat as it is in training. Losing a soldier to an accident in combat is just as intolerable as losing one in peacetime, and the lost soldier may be critical to mission success. Combat is not an excuse to discard overly restrictive rules. We should fix the rules long before combat. A few areas that need fixing follow.

Weapons. Army weapon safety procedures are designed to avoid accidents on highly controlled ranges. They are not designed to teach safe use of weapons. Where does a soldier develop the proper reflexes with his weapon to ensure others are not endangered?

Units in Vietnam developed a fairly standard set of procedures for weapon safety within perimeters. We need to rediscover and add to them. Specific procedures for mounting and dismounting vehicles, crossing fences, moving in dismounted formations, and entering secured areas are essential. We owe it to our soldiers to teach them when they should load, chamber a round, unload, and clear their weapons. We must develop rules and drill our soldiers repeatedly if they are to carry weapons safely.

Soldiers must be trained to realize they carry lethal instruments when they carry rifles. Each soldier should receive blank rounds every time he is issued a weapon. He should be required to treat blanks as live ammunition and follow correct handling procedures, so they become habits. Any unauthorized discharge of a fire arm, whether with live or blank ammunition, is a serious problem that should be followed by an investigation and appropriate disciplinary action.

Weapon safety is an individual responsibility. If we take this responsibility away from the soldier during training and give it to a safety NCO or officer, our training has generated a less safe environment. Supervision is only the final check, not the entire program.

Demolitions. "Never carry blasting caps and explosives on the same vehicle." Then how does a squad execute a target? Why do we teach this? If caps and explosives are so dangerous, how can primers and main-gun rounds, or projectiles and fuses, share the same carriers? What happens if the detonator on a TOW missile, Dragon, AT4, or 40 mm grenade is hit? Why do we prescribe rules for high explosives that we don't follow for other military munitions?

Blasting caps will detonate if subjected to heat or shock. The sensitive explosive is slightly larger than a kitchen match head. The loose cap is hazardous because it can be dropped, bumped, or stepped on. When the cap is used to prime a block of C4, however, it is protected (plastic explosive cushions the cap). It is no more sensitive than the primers in the cartridges carried by the soldier, or the detonator in a fragmentation grenade. The probability of a bullet striking it is small.

The great hazard is a soldier on the battlefield hastily crimping caps and priming charges. He may drop them, step on them, bang them into things, or inadequately fit them to fuses, thereby risking misfires. There is little hazard of accidental detonation of a prepared charge carried by the soldier. We must adopt the safe procedure of carefully preparing and inspecting charges in the assembly area. These prepared charges can then be carried on the

(Continued on page 33)

Engineer

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Combined Issue PB 5-89-3/4 is the final bulletin for 1989.
We expect to return to a quarterly schedule for 1990.

CLEAR THE WAY

By Major General Daniel R. Schroeder,
Commandant, U.S. Army Engineer School

The history of Army engineers demonstrates a clear tradition of excellence and high standards. In the coming years, the Engineer Center and School will continue its momentum of being a leader among military training institutions.

Our business is to prepare for war and be the architects of future engineer forces. The areas we address are doctrine, equipment, structure, training, and leader development.

Doctrine is the pacesetter for what we do. The Engineer Center is the proponent for the development of engineer doctrine that supports the Army's AirLand Battle operations.

Our approach to doctrine development must be integrated vertically and horizontally. It must consider the threat as it exists today, as well as the emerging technologies of both our own forces and those of potential adversaries.

Our perspective must be that of the combined arms team. As we develop doctrinal literature, we are ensuring that it is well integrated with that of the other combat arms—and represents the appropriate role of engineers within the combined arms team.

The combat developments process, based on that doctrine, must be long range and attuned to technology. And it must be holistic in terms of the role our developments will play on the AirLand Battlefield. Force design flows from our doctrine. Our force design efforts include manpower and personnel information (MANPRINT) to enhance our warfighting capabilities. We will equip the soldier—not man the equipment. Our design process is forward-looking. That is, looking well into the next century for the needs of our soldiers.

So, from the Engineer Center's first three areas—doctrine, combat developments, and force design—flows the fourth and real-time mission: training. Training is chain-of-command business. It must be consistent with our doctrine and incorporated into the life cycle development of equipment and structure. At the Engineer Center, we will provide the full spectrum of training for soldiers of all grades—from basic trainees through pre-command instruction for colonels.

Our objective is to prepare individuals to be technically proficient and tactically competent. In all cases, we will provide tough and challenging training—to standards. And more training will take place in the field under operational conditions.

One of the outstanding features of our training program is the integration of training activities among engineer students. An example is having officer, NCO, and initial entry students all training on the same event or task. We are now working to integrate BNCOC and AIT events, and we are planning the integration of officers, NCOs and new soldiers. That will be the foundation for leader development.

To paraphrase an old axiom, "the more sweat we lose in training, the less blood we lose in battle." A quality force comes from solid, tough training—supported by the three tiers doctrine, combat developments, and force design.

The engineer's central role on the battlefield is well recognized by our colleagues in arms. As we enter the last decade of the 20th century, we must maintain our focus on tough, realistic training to standards. And we must train on those tasks derived from the Mission Essential Task List of the supported command. The quality of engineer soldiers is high and will continue at those unprecedented levels if we provide the motivation and inspiration of good training. FM 25-100 is there; it is being institutionalized throughout the force and provides the needed principles and doctrine.

BRIDGE THE GAP

By Command Sergeant Major W. E. Woodall,
Commandant, Libby Noncommissioned Officer Academy

One of the most important things you can do for your military career is to attend every school and course that you can.

Civilian and military schooling both provide the promotion points needed for career advancement. Technical and college courses and degrees add points and expand your personal and professional knowledge. The Army's correspondence program allows you to take courses in most military subjects without having to attend school. These courses make it easy to add promotion points or a completion certificate to your file, and the work can be completed at your leisure.

Today, with promotion tied to attendance at certain schools, you must make the system work. No longer can you sit back and assume the best soldiers from your branch will be selected to attend a school or that your name will be on the list. Your records must be competitive with those of the next soldier's. Otherwise, he will get the schools and stripes, not you.

Army leadership designated this the "Year of the NCO," and everything dealing with noncommissioned officers—schooling, promotion system, and leadership responsibilities—have come under scrutiny. On 1 August, as part of this year's activities, we dedicated the NCO Academy to SGT George Libby, an outstanding engineer soldier who gave his life in Korea.

We have looked at the way we train soldiers at the NCO Academy, from basic and MOS-producing courses to the drill sergeant and leadership courses. We have tried to determine if there are some things we can do better, more efficiently, or to improve the quality of our training.

We have tightened entrance standards to ensure that only individuals who meet prescribed criteria attend classes. This will help reduce attrition rates because only those soldiers with the necessary knowledge, technical skills, and drive to succeed will be enrolled.

There are still some individuals who do not make it through a prescribed course because of academic, physical fitness, or personal reasons. Usually a drop from a course means a soldier failed in his responsibility to himself. He or she did not keep physically fit or keep up with required technical skills.

I believe that our Noncommissioned Officers Academy is one of the best in the Army. Our instructors are motivated, and each has a thorough understanding of the subject matter and the ability to instruct technical material.

Fort Leonard Wood's physical environment is another reason why our school has an excellent reputation. The 63,000 acres of land that make up the installation provide an opportunity to give students more hands-on time and actual field experience than most other schools can. Soldiers practice leadership skills in a tactical setting instead of "leading" in a garrison or class setting.

The school's reputation for excellence began in 1964, when it was established by the Fifth Army. Staffed by officers and NCOs, the first courses taught at the Fort Leonard Wood Noncommissioned Officers Academy were the Basic Combat Training, Leaders Orientation Course, Leader Preparation Course, and the Drill Sergeant Course. A Basic Leaders Course was added 7 years later.

As the Army changed during the 1960s and 1970s, the school kept pace; in 1973, it was renamed the U.S. Army Noncommissioned Officers Academy and Drill Sergeant School. Courses were changed, and an Instructor Training Course, Drill Corporal Program, and Primary Leadership Course were added.

The most important change, however, was the move to an all NCO staff with a command sergeant major as the commandant. In 1986, a change by then TRADOC commander GEN Carl E. Vuono, put the NCO academies directly under the command and control of the post commanding general and sergeant major.

When Fort Leonard Wood officially became the U.S. Army Engineer Center in 1987, we added training for several NCO courses, including the Advanced NCO Course (ANCOC).

Today we conduct three ANCOC, 14 BNCOC, and courses in Primary Leadership Development, Instructor Training, Initial Entry Training Cadre Training, and Drill Sergeant Training.

Our future is bright and promising, but we must continue to progress. We must constantly update our programs of instruction to ensure that we provide the best training possible and to keep pace with today's rapidly evolving Army. What works today is obsolete tomorrow. We must all look for new ways to accomplish the job.

ENGINEER OPERATIONS

By Lieutenant Colonel Philip M. Jones

> *"When we are talking about insurgency at this end of the spectrum (low intensity conflict), the engineer is no longer a combat support entity. He becomes, in effect, a maneuver element...the engineer is a fundamental element of the strategy..."*
>
> *General Fred Woerner*
> *Former CINCSOUTH*

SHORT OF WAR

Low intensity conflict (LIC) demands the application of unconventional force options by military commanders. And the formula for success is not an easy one.

In today's complex world, military resources must be closely coordinated with the political, economic, psychological and social instruments of national power.[1]

The employment of Army engineers in "operations short of war" is an excellent force option for the military commander fighting in the low-intensity, high-probability quadrant of the conflict spectrum, as shown in Figure 1. Engineers can give the commander a distinct advantage by providing a non-threatening force presence which contributes to the economic and social well-being of the host nation. In turn, this provides psychological benefits for both the U.S. and its allies.

In order for short-of-war engineer operations to have the desired impact, they must be well-planned, coordinated, and executed.

Unfortunately, no written doctrine exists for the employment of engineers in operations short of war. However, significant experience has been gained in this decade through our deployments to Central and South America. We need only to capitalize on that experience to develop consistently sound operating standards for the future. This article is intended to provide some fundamentals on how to employ engineers in operations short of war. It addresses mission selection and type, organization for short-of-war operations, and the employment of engineer task forces. It also highlights some existing force structure problems.

The principles included here apply to small unit deployments for training, major engineer exercises for training, military construction projects, and security assistance actions.

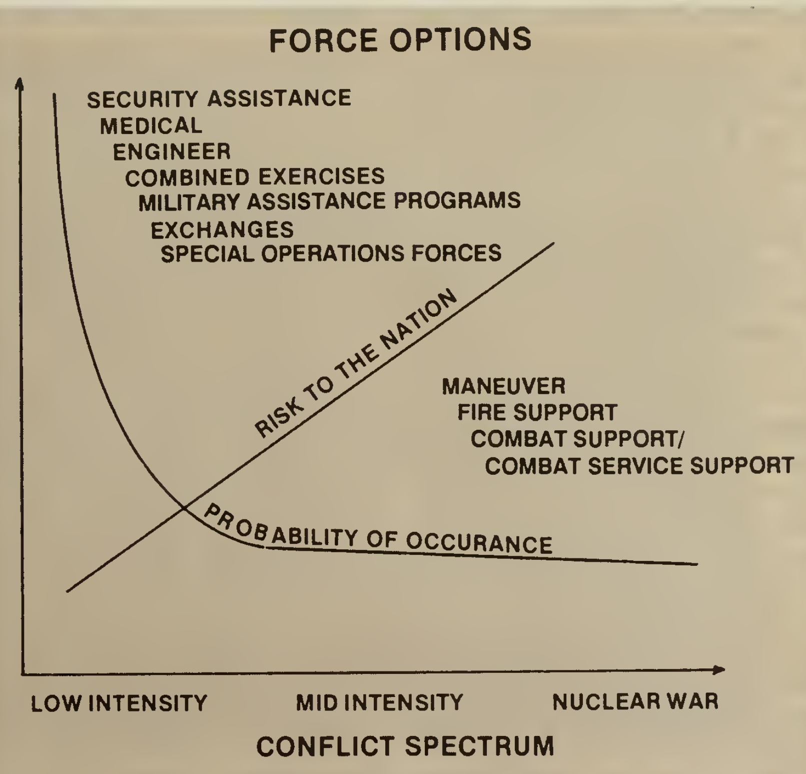

Figure 1

Mission Selection Criteria

Political considerations have a significant impact on short-of-war missions, and mission viability should be judged by four selection criteria.

First, the mission should support the long-range strategy for a region or country. Such strategies are normally developed at the unified command level.

Next, the mission must be synchronized with "country team" objectives. Such teams, staffed by

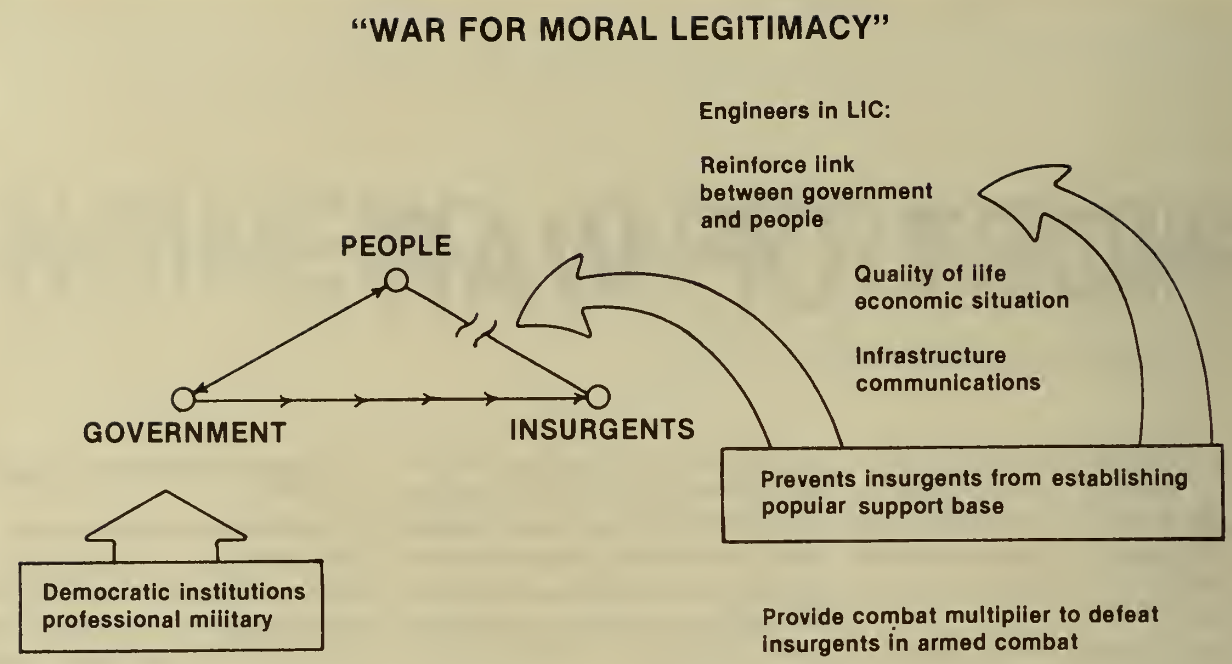
"WAR FOR MORAL LEGITIMACY"
Engineers in LIC:
Reinforce link between government and people
Quality of life economic situation
Infrastructure communications
PEOPLE
GOVERNMENT
INSURGENTS
Prevents insurgents from establishing popular support base
Democratic institutions professional military
Provide combat multiplier to defeat insurgents in armed combat

Figure 2

U.S. embassy personnel in the host nation, formulate and direct American strategies and programs within the country. For instance, if one of the country team's goals is to improve the host nation's engineering capabilities, any mission for U.S. engineers should include the participation of host nation military engineer elements.

Thirdly, missions must support a host nation development plan, or national internal defense needs. Ideally, missions should be able to do both, i.e., the construction of a road that opens new markets to rural farmers also links key military regions.

Finally, any mission should reinforce government-to-people programs. In this context, engineer missions are used as a tool to help win the "war for moral legitimacy."[2] By their very nature, almost all engineer projects do this to one degree or another because they show the government's concern with raising the standard of living for its people (Figure 2).

Mission Types

Missions that meet the criteria described above generally fall into three categories—nation building (or infrastructure development), civic action, and disaster relief.

Nation-building missions include construction and upgrading of roads and bridges, airfields, and port facilities. These have also been termed "developmental civic actions."[3]

A second mission category is engineer civic action (also called "mitigating civic action"). Normally these missions are vertical construction projects such as construction and upgrade of community centers, schools, or health clinics. These civic action missions should be selected based on their benefit to the community as a whole. Care must be taken to ensure that projects do not benefit one group or geographical area at the expense of another, i.e., repairing a Catholic church but not a Protestant church. Well drilling and construction of potable water systems fit the civic action category and have tremendous value in underdeveloped regions. Knowledgeable medical authorities indicate that one-half to three-quarters of all chronic health problems in these areas are caused by a lack of clean water supplies.[4] Such beneficial civic action missions support the government-to-people concept, and they can be conducted to compliment nation-building activities or as stand-alone projects.

A third category of engineer missions for short-of-war operations is disaster relief. Clearly, one of the most highly visible indicators of government competence is the ability to respond effectively to disaster or crisis. Accordingly, this ability to respond becomes an important aspect of "moral legitimacy." Equally clear is the need for engineers to respond quickly in a natural disaster. Since these operations are somewhat unique and situation-dependent, this article does not address them. We will focus only on the nation-building and civic action categories.

Organization

Once a mission is selected, a task force must be specifically designed to meet the mission requirements. Engineer units will provide the nucleus of that task force, with a mix of horizontal and vertical elements based on the projected tasks.

The horizontal element is normally formed from a combat heavy battalion or combat support equipment company, with specialized skills drawn from construction support companies or engineer detachments (well drillers or divers).

Vertical elements can be either general construction platoons or companies of Career Management Field (CMF) 51 soldiers or combat units. While the skills of the CMF 51 soldiers are extremely valuable, experience has shown that combat engineers can hold their own in the nation-building and civic action arenas.

The basic task force must also contain a combat service support (CSS) element and a force protection element. Engineer battalions possess limited CSS capability for short-of-war operations. Task forces are normally deployed independently to underdeveloped areas that may lack the military infrastructure expected during wartime deployment of engineer units. To further complicate logistical problems, nation-building missions are often undertaken in locales of greatest need. These areas are usually far from population centers that have a potentially supporting civilian infrastructure.

> "...experience has shown that combat engineers can hold their own in the nation-building and civic action arenas."

Thus, the task force requires augmentation with CSS elements to provide water purification and storage, showers, direct support maintenance (ordnance), repair parts resupply, authorized stockage list support, material handling and storage, contracting support, and transportation. Specialized support may also be required in the form of movement control elements (MCC/ADAG). These units must come from corps support command or EAC support and be task organized to fit the mission.

Force protection is another required element of any short-of-war task force. While this is normally a unit responsibility, the efficiency of the engineer force can be maximized by employing other-than-engineer forces in the protection role. Military police can provide basic security in a low-threat environment. Host nation infantry and paramilitary or civil guard forces have been used effectively in this role in Honduras and Costa Rica.

Use of a separate force protection element in the task force does not negate the need for development and rehearsal of a reaction

Photo by CPT Daniel B. Miles Jr.

Soldiers from the 110th Engineer Battalion of the Missouri National Guard work on a roadway construction project in Honduras. At left is German Rivera, a Honduras Highway Department Engineer, who is assisting the Army unit with the nation-building exercise.

PSYCHOLOGICAL OPERATIONS CAMPAIGN

PHASE I

Analysis of Area of Operations

- Identify key communicators
- Identify best methods of communication (radio, word of mouth, newsprint, poster)

PHASE II

Target key communicators

- Set up one-on-one discussions with mayors, regional representatives
- Set up group meeting at basecamp
- Distribute leaflets/posters

PHASE III

Conduct engineer/medical civic actions

PHASE IV

Develop information network

- Advertise good works
- Solicit feedback /information on opposition forces

Figure 3

plan that incorporates all soldiers in a total unit defense. Chapter 12 of FM 5-100 contains an excellent discussion of engineer force protection in the LIC environment.

Horizontal and vertical engineer elements, force protection elements, and a combat service support element comprise the basic building blocks of any engineer task force for short-of-war operations. The effectiveness of the task force can be greatly enhanced by the attachment of specialty elements such as long-range communications, aviation assets, psychological operations/civil affairs teams, and medical units.

Long-range satellite communications should always be included in task force planning. Such equipment provides a critical link to the logistical support structure at the port, to the host nation capital (which may be hundreds of miles away), and back to the unit's home station. Without this link, downtime on mission-essential equipment can stretch into weeks or months. The home station link is also an important morale factor for both soldiers and their families.

Aviation assets provide the capability to quickly move critical repair parts over long distances. They also provide important command, control, communications, and intelligence (C3I) and operational capabilities.

The Psychological Operations (PSYOPS) teams capitalize on the good works being done by the engineers and the attached elements of a nation-building task force. PSYOPS units are trained to communicate with the local population, providing a positive information flow on task force activities. Negative reaction to U.S. operations is often instigated by anti-American elements, who wage an organized media campaign against a task force presence. A proactive PSYOPS campaign can help neutralize such activities and prevent undue apprehension and misunderstanding among the host nation population. An example of such a campaign is shown in Figure 3.

Civil affairs teams provide the task force commander with an enhanced capability to establish and maintain good working relationships with local government officials. The good will and cooperation of such officials are indispensable to a fully successful task force operation.

An embassy liaison team is also essential for operations in countries where no U.S. military structure exists. This team provides timely information to the U.S. embassy's country team and the ambassador—who is ultimately responsible for all American activities in the country. The liaison team conducts the essential and often daily coordination with host nation officials. Such a liaison group should include an OIC/NCOIC, contracting officer's representative, public affairs officer, protocol element, and communications personnel. In countries with an existing U.S. military presence, a smaller liaison team may suffice.

The liaison team's activities include coordination with the U.S. Information Service and news media personnel, arranging payment to contractors and businesses providing services to the task force, handling important visitors, and conducting emergency contracting.

Fundamentals of Employment

The short-of-war engineer task force (Figure 4) is capable of functioning independently for expanded periods of time (60-180 days) in a low-intensity environment. Experience with engineer task forces in the 1980s has provided a reasonably sound set of fundamentals which should govern the employment of these forces. While not yet doctrinal imperatives, three fundamentals have been found to be critical in short-of-war scenarios.

Unity of Command

The engineer task force commander must have operational control of all forces employed in the area of operation. Violation of this principle can have devastating effects. Problems occur most often when a medical or combat service support element is "stove-piped" from their parent organization. Also, unnecessary confusion can occur when the embassy liaison element is not under the direct control of the task force commander. Attempts to operate these elements independently from the task force create competition for scarce resources and a scrambling of priorities.

The Abriendo Rutas exercise in Ecuador serves as a case in point. In that exercise, U.S. Army South created a forward headquarters, which handled the embassy liaison function. But because this team did not work directly for the task force commander, its priorities did not mesh with those of the task force. The absence of a sense of urgency in such situations, particularly in the area of contracting, can be debilitating to the task force mission. After-action reports from both active and reserve task forces continually identify the need for a contracting officer or a contracting officer's representative who answers directly to the task force commander.

The task force commander must have as much authority as he needs to accomplish the mission. The command of an engineer task force in an underdeveloped region that has little or no infrastructure carries considerable and often unique responsibilities. Aside from straightforward engineer tasks, he serves as a quasi-ambassador for the U.S., deals directly with the host-nation business community for the procurement of needed goods and services, allocates desperately needed medical care and civic action projects for local populations, and is often the focus of much national and international political and media attention.

The commander should also have Uniform Code of Military Justice authority over all members of the task force. Short-of-war operations are typically conducted in politically sensitive areas where soldier behavior largely determines host

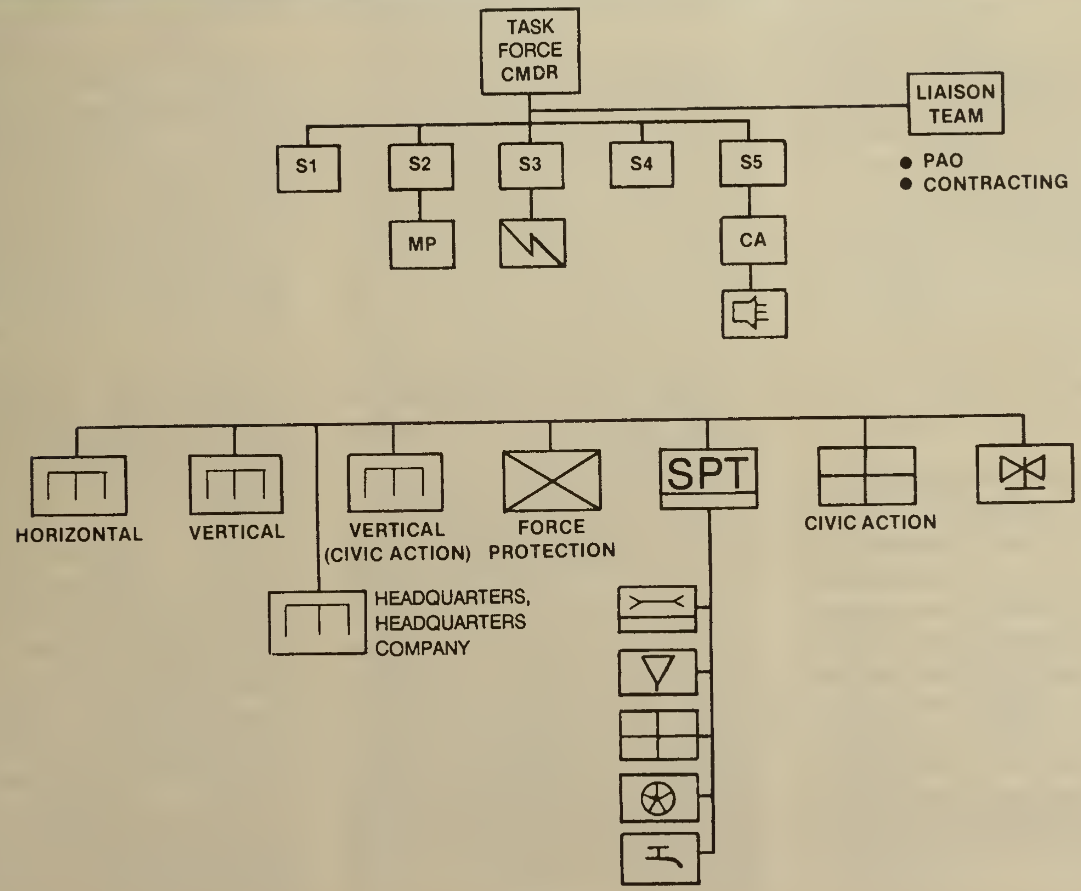

Figure 4

nation impressions of the United States. Too many incidents of misconduct by American soldiers can overshadow all the civic action projects left behind by engineer units.

Synchronization

This tenet of AirLand Battle doctrine is equally important in short-of-war operations. The importance of strategic synchronization of mission selection with country team objectives has been discussed, but synchronization must also occur at the tactical level. This involves integrating PSYOPS, engineer and medical civic actions, force protection, combat operations (either in an actual insurgency or in a training scenario), and nation building.

U.S. relations with the host nation may be damaged if units do not synchronize at the tactical level. For example, a PSYOPS or civil affairs team may promise engineer or medical help to a local host nation population without first coordinating the commitment with the task force. If this promise cannot be kept due to lack of resources, U.S. credibility will be damaged.

Such situations can be avoided if all operations are coordinated and directed by the task force S-3. While the S-5 plans for civic actions and has staff supervision, the S-3 must allocate resources for civic action missions and monitor their execution.

Integration of all elements during short-of-war operations is a difficult task that requires experience and training. Experience gained through deployment exercises must be supplemented and reinforced with instruction in service schools and unit professional development classes. We should offer instruction on synchronization of short-of-war operations in advanced and precommand courses and in senior service colleges.

> **"The host nation expects...quality products from the engineer task force. Providing that quality requires time for planning and design."**

Mission Planning

The third and perhaps most critical fundamental for successful short-of-war engineer operations is mission planning. The keys to success are early mission identification and definition, quality design and strict design review, up-front commitment of resources (for surveys, soil analyses, soil borings, and leader reconnaissance), and workable quality control plans. Last-minute changes in mission usually spell trouble in short-of-war operations—particularly in project durability. "Route selection with a bulldozer" always yields substandard results. The host nation expects—and has a right to expect—quality products from the engineer task force. Providing that quality requires time for planning and design.

The mission planning fundamental has been the discriminating factor in successful exercises throughout Central and South America. Today's short-of-war environment makes it essential that engineers convince non-engineer decision makers of the virtues of deliberate planning. Many of our task forces operate in politically sensitive arenas where the backlash from "lifting and shifting" engineer assets may exact a high price in U.S. credibility.

Force Structure Problems

The best organization and employment doctrine will fail without the necessary force structure. Recent force realignments and cuts have left engineers with a force that must do a lot of stretching to conduct successful short-of-war operations. For instance, quarry sections have been cut from combat support equipment companies and combat heavy battalions. This means we lose the equipment and experienced quarrymen from the force. While host nation support can fill this need in Europe, needed infrastructure does not usually exist in the remote areas where the U.S. has recently undertaken short-of-war operations. Also, our quarry and rock-drilling equipment is past its useful life and is difficult to maintain. At least five major engineer exercises in Central and South America have proven this to be the case.

Surveyors are being deleted from engineer brigades and combat engineer groups, and our survey equipment is technologically obsolete. Quality control and design capability is handicapped by shortages of qualified material quality specialists (soil analysts), and a reduction in the amount of instruction devoted to road and airfield design during officer basic and advanced courses.

Other needs become apparent when conducting short-of-war operations in remote regions. These include mobile water distribution capability (the airborne water scraper versus the 6,000 gallon tanker), C-130-transportable well-drilling equipment (vital for civic action missions), and specialized equipment for problem soil conditions (low ground pressure dozers, tracked backhoes, soil-stabilization equipment, and pole trucks/augers).

These shortcomings have been overcome by leasing and by some extraordinary efforts on the part of our soldiers. For example, prior to

FUNDAMENTALS

UNITY OF COMMAND

- All forces attached or OPCON to Task Force Commander
- Maximum authority delegated to Task Force Commander

EARLY MISSION PLANNING

- Quality design and design review
- Adequate planning time/allocation of resources
- Quality Control/Quality Assurance plan

SYNCHRONIZATION

- Medical civic action
- PSYOPS
- Engineer civic action
- Infantry operations/rear area protection
- Nation-building operations

Figure 5

the Ahuas Tara 88 deployment to Honduras, soldiers from Task Force Tiger pulled a rock crusher out of the property disposal yard and got it running again just in time for deployment. Shortages of trained personnel have been overcome by pooling resources from several units. But that solution will lose its effectiveness as spaces are phased out, and fewer soldiers are trained in critical construction MOSs.

To maintain effectiveness and flexibility in short of-war operations, the engineer community must strike the right balance between combat engineer and construction capabilities.

Short-of-war engineer operations are an excellent force option for commanders in a LIC or pre-conflict setting. These operations provide tremendous challenges for engineer soldiers and units, and as a result, superior training opportunities.

At the same time, short-of-war operations are highly visible and politically sensitive. They require not only excellence in military engineering, but a deft hand in working with the host nation and U.S. embassy personnel.

Adherence to three basic fundamentals will help ensure the success of engineer task force operations: (1) unity of command under a single engineer task force commander; (2) excellence in planning, design and quality control—with sufficient lead time, and (3) synchronization of all task force elements to support the commander's intent (Figure 5).

It is clear that these types of operations are here to stay. In fact, it is a safe prediction that short-of-war engineer exercises will increase in the future as more commanders begin to appreciate them as a valuable force option.

Now is the time for the engineer community to take a systemic look at our short-of-war operational requirements and attempt to balance them against wartime requirements.

Failure to structure for these politically-sensitive, high-probability missions may result in the loss of engineer capabilities that are critical to our national interests.

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Notes

[1] Morellis and Ferguson, "Low Intensity Conflict and Operational Perspective," *Military Review*, Nov. 1984, p 9.

[2] Fishel and Cowan, "Civil Military Operations and the War for Moral Legitimacy in Latin America," *Military Review*, Jan. 1988, p 39.

[3] Ibid.

[4] Author's discussions with Command Surgeon, USSOUTHCOM, Apr. 1988.

The Engineer Officer as Battalion S-2

By Major Charles L. Toomey

The lack of solid engineer reconnaissance has the potential of turning battlefield success into sudden defeat. At the very least, it will result in the unnecessary loss of lives, equipment, and/or time.

Engineer intelligence is a critical part of Intelligence Preparation of the Battlefield (IPB). This article is directed toward officers serving as S-2s in combat engineer battalions that provide direct or general support for maneuver divisions. It advocates an expanded intelligence role for these officers.

Too often, junior officers assigned as S-2s are limited in their effectiveness because they lack a full understanding of their special role in the combined arms arena.

The engineer battalion S-2 often finds himself torn between two distinct duties. On one hand, he is the engineer battalion's security officer, primarily responsible for security matters within the unit. On occasion, when a field exercise requires it, he may be called upon to do some engineer reconnaissance planning for short-term missions. On the other hand, he serves as the intelligence officer for the division engineer. In this role, the S-2 collects and forwards data that may be relevant to both engineer and maneuver elements in the division's area of operations.

Being the intelligence officer for the division engineer is the more difficult of the two duties. The job demands experience, a passion for detail, and a broad vision that goes beyond the limits of the battalion's garrison activities or field exercises.

And it is a duty that, unfulfilled, can contribute to diminished combat effectiveness for the division.

A good example of the consequences resulting from an inadequate engineer intelligence network was the 24th Infantry Division's breakout from Korea's Pusan Perimeter in September 1950. The operation required crossing the Naktong River, a formidable obstacle ranging from 300 to 600 feet wide and three to 18 feet deep. The Naktong was not a particularly difficult crossing for the engineers, provided that they could obtain the necessary bridging equipment.

But there was a serious problem with the engineers' estimate for the operation. Engineer planners had concentrated their attention almost entirely on the Naktong River, and had overlooked the Kumho River, which had to be crossed before the division's assault crossing of the Naktong.

Heavy rains had swamped the area just prior to the scheduled assault, and fording sites on the Kumho had turned into raging, nearly impassable torrents. The engineers finally succeeded in crossing elements of the division, but only after the operations order had been drastically changed and the unit had been significantly delayed.

Today, the majority of the S-2's time should be spent preparing the battalion (and thus the division) for war. Of course, some S-2s are now muttering to themselves "...the peace-time requirements for physical security, personnel clearances, key control, and other areas will be the things that eat my lunch if I don't do them well."

True, those things are within the S-2's area of staff responsibility. But, it must be remembered that company executive officers, first sergeants, platoon leaders, and company commanders (preferably in that order) should worry about those matters on a daily basis and work the fixes for problem areas.

S-2s should teach those leaders what they need to know about security matters, monitor the battalion's security status, and help the unit leaders when they really need it.

Two types of engineer battalions drive my thinking for S-2 responsibilities: Units that are forward deployed, and units that have contingency missions (usually CONUS-based).

Forward-Deployed Battalions

Forward-deployed battalions generally have well defined missions in an assigned sector. Although they may be close to the ground on which they would fight, their engineer intelligence needs are not diminished. Regular adjustments to the unit's mission, aggravated by the usual personnel turnovers, require constant training, reconnaissance, and planning updates.

Each S-2 should prepare detailed handbooks for specific engineer-related areas of interest, including:

Processed construction materials. Note locations for sized lumber, large steel members, crushed gravel, precast concrete, geo-textile sheeting, wire, and cut timber. Make notes as to their general availability during a yearly cycle—some inventories may experience cyclical shortages based on the local economy and supply and demand.

Locations of forests and other expedient engineering materials. Locate potential sources for field engineering and construction materials. Identify types of wood, average diameter of trees, average spacing, and degree of accessibility (i.e., near major highway or good internal trail network). Note both active and closed quarries. Include equipment that could be used to improvise float bridging or rafts, including existing commercial facilities. Identify locations of heavy-load railroad flatcars for possible expedient Class 60 bridging.

Construction equipment. Identify possible sources of locally owned equipment, from hand shovels to cranes. Work through the division staff for approved host nation support. If indigenous construction equipment differs greatly from ours, prepare English-language instructions and/or labeling decals to install on control panels.

Highways and roads. Standard route reconnaissance information applies, but critical points along routes susceptible to interdiction should have, as a minimum, planned bypasses and estimates of the materials and time required to place the primary route back into operation. Include railroad data and ground lines of communication in this category.

Bridges. Examine in detail every bridge along primary and alternate routes within the area of operations. Information for each bridge should include its dimensions and load classification. In the event those bridges are destroyed, prepare sketches of bypass routes to replacement bridge sites. Tabulate estimates of materials and time required to reopen main bridges, including figures for each method of repair (from field expedient construction to standard fixed or float bridging). Also, estimate the materials and time required to reinforce low-strength bridges and increase their load classifcations.

Airfields. Include data on airfield width, usable length, runway orientation, pavement (thickness, type, soil, asphalt, concrete, matting), taxiways, parking and loading areas, and on-site material-handling equipment. Estimate the number of aircraft operations per day (takeoffs and landings) and capability for handling personnel and equipment. Sketch land-use areas around the airfield, including traffic flow into

Photo by Phil Howell

"Being the S-2 of an engineer battalion is not an easy job when the duty is properly executed...(It) requires careful thought, considerable effort, persistence and patience."

and out of loading support areas.

The battalion S-2 can assist in unit deployment training by producing video tapes of planned routes. Videos can be either a complete route, from garrison through a start point to a release point, or be through expected trouble areas only.

To film the route, travel during daylight at wheeled-convoy speed and keep the volume turned off. Later, dub over the tape with information regarding constrictions, gradients, place-names, grid locations, and critical tactical information about the surrounding terrain, i.e. "Vehicles at this point can be engaged by direct fire from Hill 233 at 2 o'clock".

Route videos can be used as training aids for newly assigned drivers and leaders. You may even make points by sharing the film with the maneuver unit supported by your battalion.

Finally, forward-deployed divisions may be ordered out of their assigned sector. The engineer S-2 should expect such a possibility and begin collecting and preparing axis-of-advance intelligence (versus route intelligence) to assist in the planning and movement of the division. Knowledge of friendly engineer capabilities along any given axis of advance is especially critical. Minute detail is not important until a general direction is provided, but initial data and a recommendation by the division engineer may influence that decision.

Contingency Battalions

The S-2 of a contingency battalion can use the preceding ideas to help prepare the unit—and the division—for action upon arrival in the mission area. The major difference is the number of possible missions and, thus, the number of workbooks needed. The best method for organization seems to be either by country or objective area.

Let's take another look at some of the major preparation areas already mentioned. We will add details for the specific needs of the contingency battalion:

Processed construction materials. In addition to the items already mentioned, determine electrical voltage in the objective area (110 or 220 volts.) Do soil conditions require special types of cement? Is there water for dust control and construction, and water for consumption by friendly forces? These are just a few questions that need to be answered before deployment.

Construction equipment. Insufficient construction equipment in the objective area can be a real warstopper. Conservative estimates for engineer equipment needs should drive the force structure, but there is no guarantee that all of the organic equipment will make it in. Find out the types of in-country construction equipment that exist in the contingency area. It takes real intelligence work to keep this type of information updated.

Each contingency engineer battalion S-2 should subscribe to professional engineer journals that keep the civilian construction industry appraised of what is going on throughout the world. *Engineering News Record* is an excellent example. You may find that some indigenous equipment in the objective area may also be distributed by local commercial firms near your stateside base. Plan to use local equipment dealers for emergency training and briefings and as possible sources for resupply of parts and accessories. You may be able to plan regular familiarization training sessions for your equipment operators with local firms that are sustaining members of the Society of American Military Engineers.

With all of the possible missions that a contingency engineer battalion may have, it is obvious that the S-2 will have a difficult time keeping up with the latest engineer-related developments in each mission area. He needs help.

Other officers in the battalion can provide assistance. The battalion commander may appoint unit officers as foreign area project officers. These lieutenants and captains (or majors, if they have experience in a specific area) may be assigned a specific mission area to monitor. That officer would keep the S-2 informed of all developments in the region that could affect the battalion's ability to meet its contingency mission. Selected officers would, for example, scan commercial publications for news of the opening of new airports, desalinization plants, or the status of highway construction in other countries.

A side benefit of such research is the expanded professional development of the officers involved. Officers who are trained to observe and track such engineer-related developments in the world will be better leaders for it somewhere down the road.

Common Ground

Several points on engineer intelligence responsibilities have common ground for both forward-deployed and contingency battalions:

Learn to work with your own battalion staff. The S-4 needs to be involved in the indigenous Class IV issues; the maintenance officer in the equipment issues, and both the S-3 and the ADE in problems and issues involving terrain, operations, and training.

Find out who to talk to on the division staff in addition to the G-2. For instance, the G-5 can help you prepare indigenous labor workforce estimates. Use the ADE and his staff to run interference for you at division and corps levels on engineer intelligence issues that may be outside the G-2's area of interest.

Develop close working relationships with the S-2s of other maneuver battalions and brigades. It's important that all engineer S-2s support each other and develop an engineer intelligence network.

Photo by Phil Howell

S-2s of forward-deployed engineer battalions should prepare detailed handbooks for their assigned sector and axis of advance to include all bridges along primary and alternate routes.

Maintain an engineer intelligence collection plan as part of your "battle book," or individual contingency OPLAN. Identify what needs to be known, by what time it needs to be known, and how it will be collected. Consider every intelligence and collection asset available to the division (from intelligence battalion equipment to infantry battalion scout platoons, to engineer reconnaissance patrols). Continually coordinate your engineer intelligence collection plan with the G-2's collection plan for the division; they should support and complement each other.

Become an expert in the request procedures for aerial imagery. Learn how to read, in detail, aerial photographs for pure engineer intelligence.

Develop programs for reconnaissance training in coordination with the S-3. Although our engineer sergeants' primary recon tasks remain sapper-related (bridges, highways, rivers, etc.), we must emphasize that all reconnaissance performed within a division's area of operations is tactical in nature.

For example, when a squad checks out a road, they should ask such questions as: "...can friendly movement be observed along this road from that hill...," or "...could this be a possible anti-tank ambush site?" The 19D soldiers' manuals provide a good foundation on tactical reconnaissance.

Coordinate training programs on how to identify types of enemy formations by noting specific vehicle types and their function. Engineer platoons operating in front of, or among, friendly maneuver units automatically become intelligence collectors. They should be trained to distinguish between a regimental advance guard and the main body of a regiment by virtue of equipment, tactics, and time of arrival on the battlefield. This difficult task requires a high level of professional dedication. As the S-2, you need to work with the S-3 to ensure that appropriate training is available.

Being the S-2 of an engineer battalion is not an easy job when the duty is properly executed. In particular, the position's inherent responsibility to serve as the division engineer's intelligence officer is a complex business that requires careful thought, considerable effort, persistence, and patience.

The collection and assessment of raw data that later becomes usable engineer intelligence is a process that cannot be accomplished by one S-2 during a single period in a battalion's history. It is the product of a continuing process of dedication and vigilance whose merits may not be immediately apparent.

But someday, the payback in critical engineer intelligence may prove invaluable.

Just ask the soldiers who had to wait by the banks of the Kumho River in 1950.

Major Toomey is currently a student at the Command and General Staff College. His previous assignments include G-3 Training Officer for the 3rd Armored Division; S-3 of the 23rd Engineer Battalion, and Assistant Area Engineer for the Riyadh District, Saudi Arabia. He holds a masters degree in civil engineering from North Carolina State University, and is a registered professional engineer in North Carolina.

LEADERSHIP AND QUALITY CONSTRUCTION

By Major Edward Hayes and
First Lieutenant Terry Wendt

Everyone likes quality. From the clothes we wear, to the cars we drive, to the food we eat. If that's so, then why is quality such an elusive thing? How many times have you heard your friends, neighbors, or family complain about the shoddy materials or workmanship that they've had to endure at one time or another?

The same idea applies to troop construction projects. Everyone involved wants a quality product—but it doesn't always happen. Quality does not magically appear in anything, much less in an engineering project. What must leaders do to ensure that quality is an integral part of their construction product—and not just an exercise in lip service?

Quality is a leadership challenge that can be met using a three-step approach:

- ▶ Identify the standards
- ▶ Evaluate and conduct necessary training
- ▶ Establish and enforce quality control

All three steps share a common denominator of leadership. Making quality happen is up to the chain of command. A close look at each step, and how they fit together, will show how the diligent pursuit of quality can pay big dividends for both the project and the soldiers who work on it.

Standards

What standards do you use to measure the quality of your construction? How can your soldiers tell if their work is satisfactory?

In the theater of operations (T/O), Army construction standards are detailed in the Army Facilities Components System (AFCS), TM 5-300-series manuals. The AFCS identifies two T/O standards—initial and temporary. Initial construction is intended to have a useful life of six months or less. Temporary construction uses more durable materials and has a theater life of up to 24 months.

The AFCS also uses the four climatic zones of temperate, frigid, tropical, and desert to determine the construction standards. Simplicity, ease of construction, and function take precedence over aesthetics in T/O construction.

On the other hand, structures built to last beyond 24 months are called troop construction projects. There is no consolidated reference manual detailing troop construction standards. Workmanship requirements vary regionally, especially overseas where host nation safety standards, construction methods, and materials may be totally different. Normally, these projects support the installation's Directorate of Engineering and Housing (DEH), which establishes the general construction quality expectations. Troop construction, therefore, requires a balance between function and appearance.

Leaders must set the standard for workmanship by first analyzing the purpose of the project. Permanent or highly visible structures require a higher level of craftsmanship than temporary or utilitarian ones. For example, if you're renovating a child care facility, even the smallest imperfection may detract from the project's appearance and safety. Conversely, if you're constructing gravel storage bins, there's little need to sand the lumber or to patch stray nail holes. The level of craftsmanship, therefore, must be in tune with the intended character of the finished product.

Workmanship standards are found in local, state and national building codes. Their purpose is to ensure the public safety by describing, often in minute detail, the minimum acceptable performance criteria of the finished product. Codes are legally binding, and they are written in precise language in order to define exactly what constitutes compliance and what does not. Simply put, codes establish tests which the project must pass.

Building code compliance is normally addressed during the design phase. Designs are carefully reviewed prior to their approval to make sure they comply with applicable codes. A basic knowledge of code requirements enables leaders on the jobsite to identify code violations before they become difficult to correct. A current and easily accessible library of building codes is an absolute necessity in your unit. If you do not have them on hand, your DEH can provide the appropriate code requirements.

Specifications complete the definition of acceptable workmanship by conveying the intentions of the client. For example, a specific set of plans may call for a door in a certain location. Codes only specify the safety aspects the door must have in certain situations. They don't indicate what kind of door, the type of finish that should be applied, or what grade of hardware to use.

Specifications, which accompany the drawings, answer these questions. They range from simple notes appearing directly on the drawings to separate volumes hundreds of pages long. Specifications most often describe the grade or quality of materials to be used in a project. They can also describe construction techniques, define the acceptable margin of error, and set the performance standards for the project.

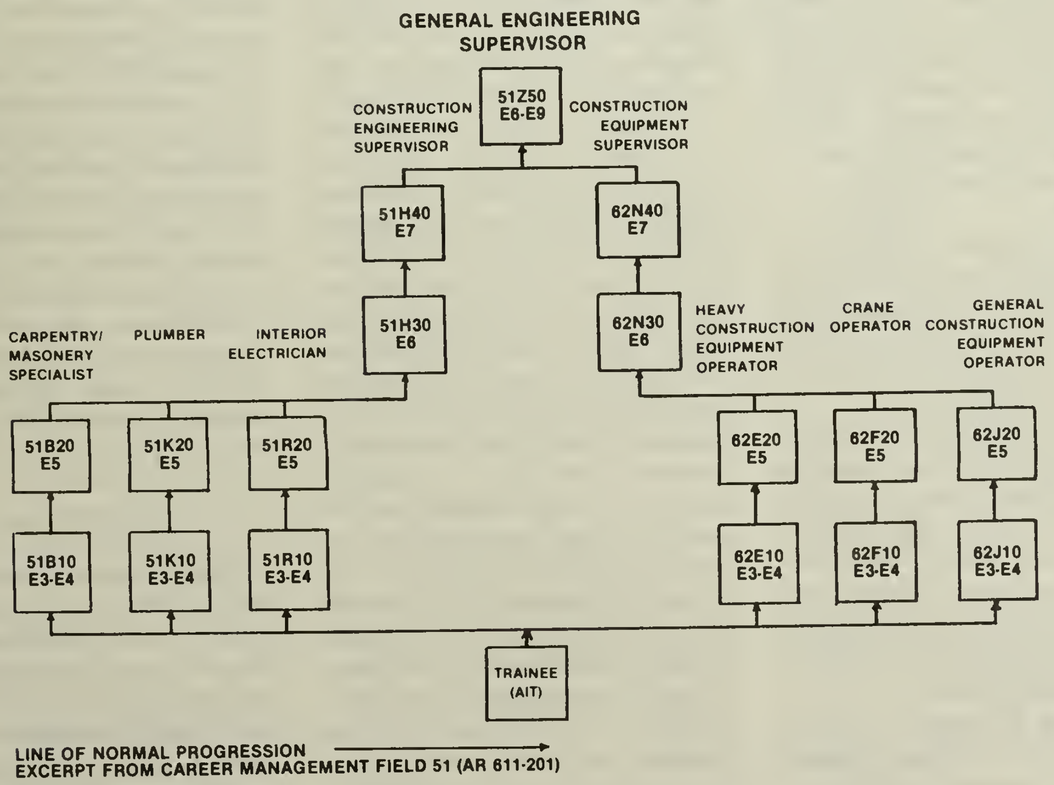
Specifications may change during the course of a project due to material availability or budget constraints. Before construction begins, leaders must ensure that they are provided with adequate specifications. However, they also owe it to the client to recommend changes that will improve the function, safety, or appearance of the finished product. Once specifications are clarified, adherance to them will go a long way toward achieving quality construction.

Training

Because of normal personnel turnover and project complexity, (i.e., T/O construction versus troop construction), leaders must continually evaluate the individual and collective levels of craftsmanship in their units. Several methods exist to help leaders evaluate soldier expertise levels and training requirements. The most common are individual counseling, supervisor recommendations, review of workmanship on prior projects, and performance testing. This information should be analyzed to determine why the unit has these strengths and weaknesses and what steps can be taken to improve the weaker skills.

Young soldiers new to your unit have an "experience gap"—the difference between the skill level achieved through formal instruction and the skill level achieved through hands-on construction project experience. Upon graduation from Advanced Individual Training (AIT), soldiers in Career Management Field (CMF) 51 (Figure 1) have received introductory training in many areas.

The NCO Education System (NCOES) provides formal instruction for NCOs as they advance in rank and responsibility. In the Basic NCO Course (BNCOC), sergeants


GENERAL ENGINEERING SUPERVISOR
51Z50 E6-E9
CONSTRUCTION ENGINEERING SUPERVISOR
CONSTRUCTION EQUIPMENT SUPERVISOR
51H40 E7
62N40 E7
51H30 E6
62N30 E6
CARPENTRY/ MASONERY SPECIALIST
PLUMBER
INTERIOR ELECTRICIAN
HEAVY CONSTRUCTION EQUIPMENT OPERATOR
CRANE OPERATOR
GENERAL CONSTRUCTION EQUIPMENT OPERATOR
51B20 E5
51K20 E5
51R20 E5
62E20 E5
62F20 E5
62J20 E5
51B10 E3-E4
51K10 E3-E4
51R10 E3-E4
62E10 E3-E4
62F10 E3-E4
62J10 E3-E4
TRAINEE (AIT)
LINE OF NORMAL PROGRESSION

EXCERPT FROM CAREER MANAGEMENT FIELD 51 (AR 611-201)

Figure 1

Photo by SSG David H. Funk

As part of a troop construction project, soldiers from the 1249th Engineer Battalion work on a rest facility at Paulina Peak in the Deschutes National Forest in Oregon.

learn the supervisory skills and complex construction techniques needed for their new MOSs. In the Advanced NCO Course (ANCOC), staff sergeants are taught advanced construction management techniques that they will use as platoon sergeants and project NCOICs.

Lieutenants in the Engineer Officer Basic Course (EOBC) are taught Army construction techniques and construction management. This gives them a basic knowledge of troop construction, which they will use later as project OICs.

The intent of formal instruction is to teach soldiers the basic concepts behind each task. There is not sufficient "hands-on" training included to make them skilled construction troops or supervisors. Soldiers must practice their newly acquired skills to make them proficient enough to produce quality results.

To support the hands-on training, your battalion S-4 should stockpile appropriate materials for carpentry, masonry, electrical, and plumbing MOSs. Horizontal construction skills can be enhanced through range and road maintenance projects that are not time-sensitive.

Similarly, union tradesmen such as carpenters, masons, and plumbers, receive hundreds of hours of formal instruction and are apprenticed in their respective fields for several years before they are certified. During this apprenticeship they practice what they learned in the classroom. Formal and informal instruction, supplemented with practical experience and supervised by personnel proficient in the trade, closes the experience gap and enables troops to construct any project with superior results.

Once the standards are identified by codes, specifications, and knowledge of construction practices, leaders must communicate them to their soldiers. Depending on the unit's experience, this sharing of ideas can range from simple to complicated.

If the unit has performed similar work before, an effective approach is to compare past results with those expected from the project at hand. This allows troops to recall mental images of past work, which they can then use to judge their current workmanship.

Inexperienced troops facing new construction techniques lack the data base from which to draw images. They require a detailed description of what is expected of them. In this case, a picture is worth a thousand words. Drawing a sketch of what the leader defines as "good construction" helps transfer the idea from one person to another. It also serves as a means to determine whether the standards were met.

Another effective way of training to standards is to have the troops build a small portion of each project phase for use both as a model and the craftsmanship standard. For example, prior to beginning the electrical rough-in phase, troops assemble a sample of each type of connection and wiring sequence used in the project.

This approach has two benefits. First, it results in a three-dimensional portrayal of acceptable workmanship that soldiers can use as a reference. Second, it serves as a vehicle for hands-on training. Experienced soldiers can train inexperienced soldiers on the construction quality standards, code requirements, safety, and craftsmanship required for each task.

The time, effort, and materials spent on test sections and models are well worth it, and inevitably result in improved productivity and product quality.

Quality Control

Once the standards are identified and soldiers are trained and certified, leaders must ensure their troops apply the training to produce quality results. This is best done by formulating and implementing an effective quality control (QC) and quality assurance (QA) plan.

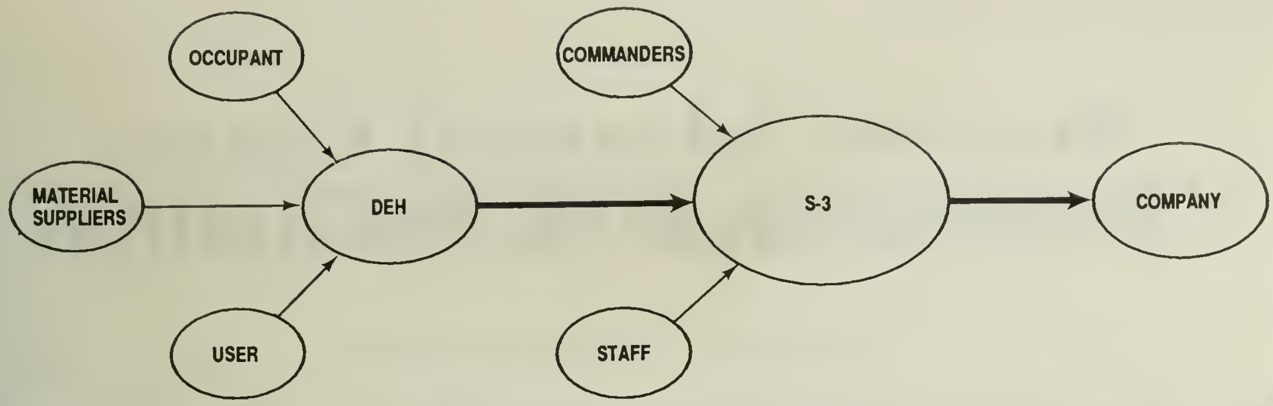


Figure 2

The QC/QA plan outlines a systematic quality enforcement program, just as a training schedule outlines a systematic training program. And it should be adhered to just as religiously. Initiating and enforcing the QC/QA plan is the key to quality troop construction because it identifies the accountable and responsible chain of command.

Quality control is the constructing unit's responsibility. The project OIC and NCOIC plan how to monitor the level of craftsmanship on the jobsite. The QC plan should identify the tasks to be checked, who checks them, how often they are checked, and briefly describe how each task is inspected.

For example, the QC plan calls for the NCOIC to check the formwork prior to concrete placement to ensure the forms are the correct size, are properly braced, and are level and plumb. This is accomplished by consulting the plans to verify that form components are in their proper place, checking dimensions with a tape measure, and using a level to check for horizontal and vertical alignment. Thus, the QC plan needn't be complicated or technically overwhelming. Common sense will usually give you the most mileage when it comes to troop construction.

The soldier doing the work must be the first level of inspection of any QC plan. Mistakes are quickly discovered and best corrected when soldiers inspect their own work. Soldiers should expect consequences for second-rate workmanship. "Do it right or do it over" makes quality workmanship a habit.

The second level of QC responsibility is the soldier's immediate supervisor. He must continually inspect the project to convince soldiers their work will be inspected and construction standards will be enforced.

Quality assurance is the responsibility of the battalion S-3, who focuses on QA to ensure compliance with plans and specifications. The S-3 must be the focal point of the project, coordinating the actions of everyone involved (Figure 2).

From this central position, the S-3 and his section can control everything that may influence the project, including design changes, material shortages, and construction errors. He can then quickly resolve any difficulties that may arise. QA inspectors must be readily available and accessible for the QC/QA plan to work. If they are not, the S-3 becomes a bottleneck, rather than a focal point.

The feedback provided to the constructing unit tells them if they are on target, and what they must do if they are not. In essence, the S-3's QA program ensures the quality of the constructing unit's QC.

Since most projects are troop construction, leaders must continually conduct hands-on training to raise their soldiers' level of construction expertise beyond theater of operations standards. Leadership must also clearly define the standards of quality and hold the project chain of command accountable.

As the habit of craftsmanship grows stronger, troops spend less time correcting mistakes and more time producing results. Enthusiastic, confident, and self-motivated soldiers require less supervision and few reminders that quality counts. Good workmanship becomes a personal goal. It becomes something they expect and demand of themselves because they enjoy the pride and sense of accomplishment that goes with a job well done.

And when that happens, that elusive thing called quality becomes a natural part of troop construction.

Major Hayes is assigned as Director of the DEH in Pirmasens, West Germany. He holds a B.S. degree from Norwich University, an M.S. in civil engineering from Purdue University, and an M.S. in systems management from the University of Southern California. Major Hayes is a graduate of the Command and General Staff College.

Lieutenant Wendt is currently assigned as a facility planner and building inspector, Directorate of Engineering and Housing, Fort Belvoir, Virginia. He holds a Bachelor of Architecture degree from the University of Minnesota.

Reserve Advanced Course Restructured for Flexibility

By Lieutenant Colonel Charles A. Doll

Reserve Component (RC) officers will have several methods for completing the newly restructured Engineer Officer Advanced Course (EOAC-RC). Implementation of the restructured course begins in October 1989.

Under the new guides, officers may attend the 20- or 14-week course with their active duty counterparts. Or, they may complete course requirements using a combination of methods, including resident modules, resident U.S. Army Reserve Forces (USARF) phases, correspondence courses, and inactive duty training (IDT) with a USARF School.

The reconfigured EOAC-RC includes a new Company Commander's Course, as shown in the table. All RC officers must complete phases I, IIA and IIB, and either phase IIIA or IIIB of EOAC-RC for qualification. Phase IIIA is for officers in combat engineering organizations, and phase IIIB is for officers in sustainment engineering organizations.

The length of time allowed for soldiers to complete EOAC-RC course work has also changed. The course must be completed in 2 years, beginning with the initial enrollment date. A 1-year extension may be granted by the Engineer School with written justification. Soldiers who do not fulfill all course requirements within the authorized period forfeit credit for course work that is more the 3 years old (FORSCOM/TRADOC Regulation 135-3, paragraph 6-3).

Additional information is available from the U.S. Army Engineer School, ATTN: ATSE-DAC-NG, Fort Leonard Wood, MO 65473-6650.

Lieutenant Colonel Charles A. Doll is the Senior Army Reserve/National Guard Advisor to the Engineer Center and the Military Deputy for the Directorate of Training and Doctrine, U.S. Army Engineer School, Fort Leonard Wood.

EOAC-RC PHASE CONVERSION CHART

Active Duty Modules (2 weeks ADT per Module)	EOAC-RC Phases (FY 85 - FY 89)	EOAC-RC Phases FY 90
		Phase I Company Commander's Course (AT/ADT, Resident)
① Leadership & Communication Skills	Phase 1 (IDT/Correspondence)	Phase IIA (IDT/Correspondence)
② Combined Arms Doctrinal Foundations		
③ Combined Arms Defense	Phase 4 (USARF School) (AT/ADT)	Phase IIIA (Combat Engineer) - OR - Phase IIIB (Sustainment Engineer) (USARF School, AT/ADT)
④ Combined Arms Offense		
⑤ Engineering Foundations	Phase 2 (USARF School) (AT/ADT)	
⑥ Lines of Communication	Phase 3 (Correspondence)	Phase IIB (Correspondence)
⑦ Basecamps and Contingencies		
TOTAL - *14 weeks ADT*	*TOTAL -* *4 weeks AT/ADT* *2 correspondence phases*	*TOTAL -* *4 weeks AT/ADT* *2 correspondence phases*

AT: Annual training *ADT: Active duty for training* *IDT: Inactive duty training*

M916 TRACTOR ACCIDENTS

By Tom Moran

Several serious accidents have occurred recently in which the M916-M17 tractor-trailer rig has crashed while hauling a D7 bulldozer. Three soldiers have died while using this rig in the past 10 months. Accidents have occurred at units in Germany, Korea, and the United States; they were not confined to a single geographic area.

We know from analyses of these accidents that the drivers lost control of their equipment on long downhill grades. Problems encountered include:

- Excessive speed when entering steep grades
- Excessive use of brakes, which caused overheating
- Improper use of the engine retarder
- Transmission disengagement due to engine racing

Photos by 1LT Anne Tanner

The crash of this M916-M17-D7 rig occured on a steep grade in Germany. The soldier/driver was killed, and a soldier/passenger was seriously injured.

The wide scope of engineer projects often requires hauling loads that approach or exceed the rated capacity of the equipment. The M916-M17-D7 combination puts great demands on even the most skilled drivers. Extreme caution is required when operating this rig on downhill grades.

The Tank and Automotive Command (TACOM) is preparing some materiel change actions to improve equipment safety, which will help when they are implemented. In the meantime, the following suggested actions will help ensure the safe operation of the M916 rig:

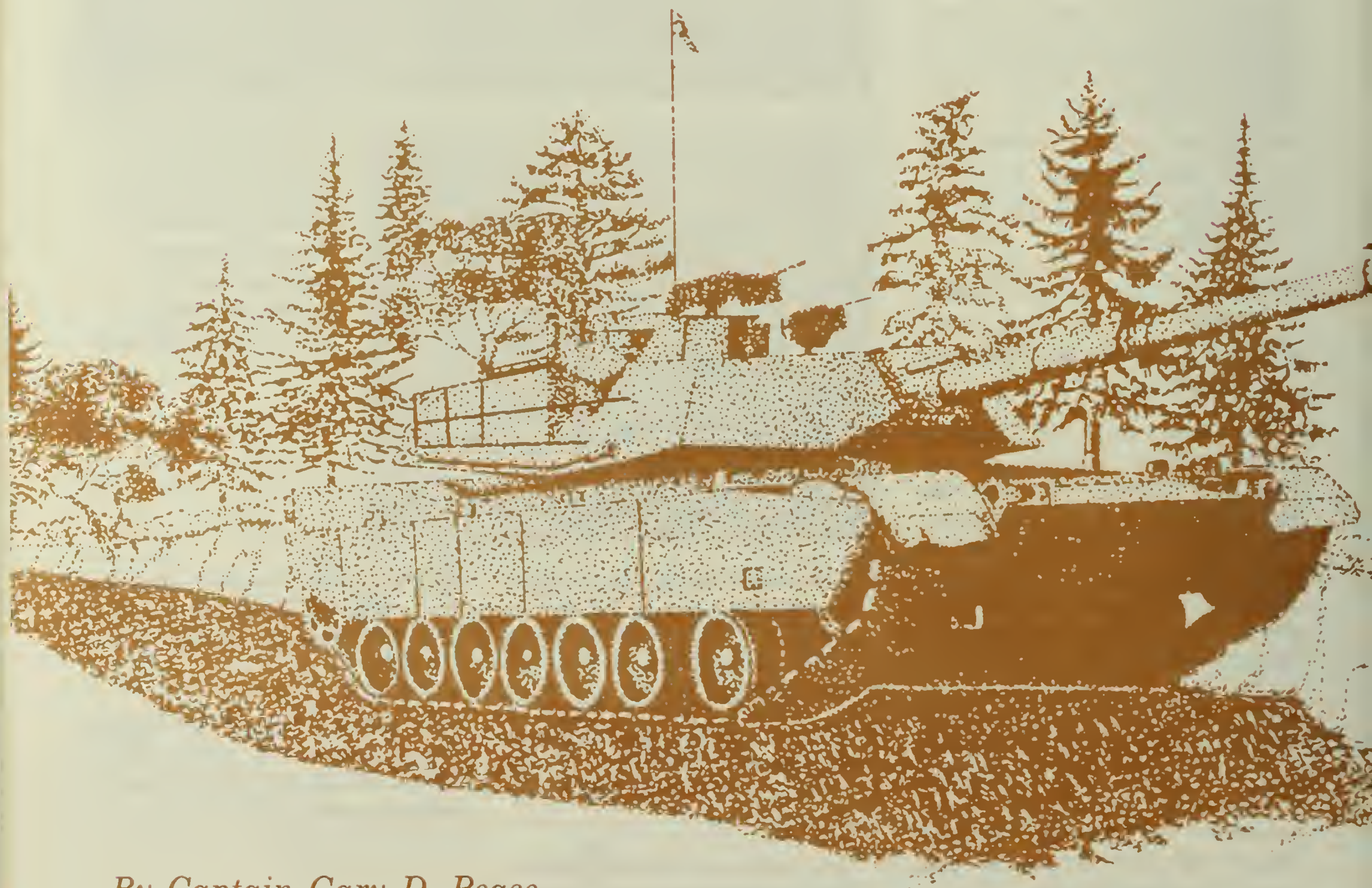
- Train heavy equipment operators in the proper use of the braking systems. They must drive the rig when MOS-trained drivers are not available.
- Perform regular and thorough maintenance inspections of the braking system on the M916 tractor-trailer.

Your safety team at the Engineer Center cares about you! We want to hear from you. The office symbol at Fort Leonard Wood is ATZT-S, and the telephone number is AV 581-7174.

Tom Moran is Director of Engineer Branch Safety at Fort Leonard Wood. He has a masters degree in business administration from St. Louis University.

Rocks over troubled waters:

a floating road for tanks



By Captain Gary D. Pease

Adequate space for military training has become an increasingly "nip and tuck" issue in Europe over the last several years. While most recognize the need for military maneuvers and live-fire ranges, increased land use by the private sector has put a squeeze on expansion of existing training areas.

The need for maneuver battalions stationed in Germany to maintain their live-fire proficiency has put great demands on those training areas, particularly the tank gunnery ranges at Grafenwoehr.

Grafenwoehr Training Area, under the direction of 7th Army Training Command, is one of the few places in Europe where M1 Abrams tank crews can fire their main gun. And Range 132 is usually the first range a tank crew will fire before moving on to other tank crew qualification ranges. It is on this initial range that tank crews confirm their "battle sight zero."

To complete the Range 132 firing table, tank crews move along a single road during the course of firing. Defilade firing positions, protected positions from which tanks can simulate tactical firing, are situated at various points along the road.

Because of the size of the lane and the nature of the required tank gun firing, tanks must follow each other single-file down the road. This results in a continuous bottleneck on Range 132, with a long line of tanks waiting their turn to fire.

To increase the ability of Grafenwoehr to handle zeroing of tanks on Range 132—without having to expand the land area—the 7th Army Training Command decided to build a second, parallel road from which tanks could complete their initial firing.

The project, which began in May 1988 and will be completed later this year, is being administered by the European District of the Army Corps of Engineers. Nearly four million dollars were allocated for construction of the new road.

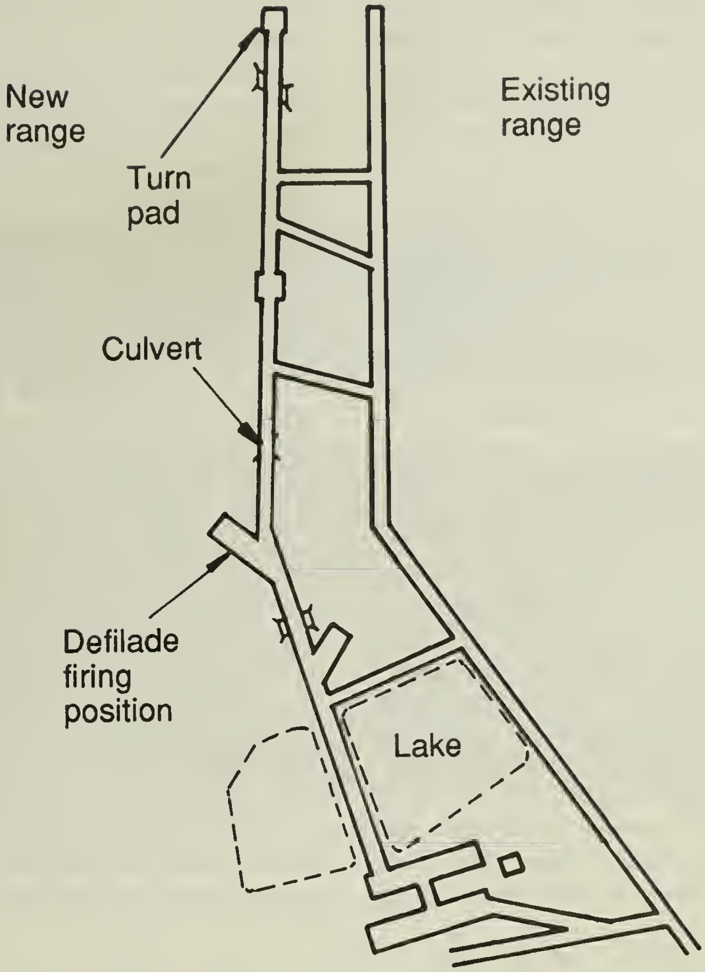


Figure 1

One of the early stipulations of the project was minimum interference with on-going firing on the range. It was decided that mission-essential firing would determine the daily time periods available for construction work. Because of the unusual work schedule and the possibility of workers encountering unexploded ordnance during construction, the decision was made to use a troop construction unit to build the new road.

The Corps of Engineers then contacted the 18th Engineer Brigade in Karlsruhe for design and construction assistance.

The brigade gave the job of designing the project to the 6970th Civilian Support Group, a German labor unit assigned to the 18th. They were given the job because of their long-standing familiarity with conditions at Grafenwoehr, and their extensive background in design and construction of facilities all over Germany.

Responsibility for construction of the road was given to Bravo Company, 79th Engineer Combat Battalion (Heavy), also from the brigade. About 100 soldiers and 50 pieces of construction support equipment were deployed to Grafenwoehr from their home station in Karlsruhe.

An overview of the project (Figure 1) shows the new road, 1,500 meters long, which parallels the existing range road, two defilade firing positions, two concrete turn pads, and three concrete culverts. This configuration allows maximum use of existing target systems in the downrange area.

The primary challenge facing the design engineers was the extremely swampy conditions over which the road had to be built. The entire area is underlaid by a massive peat bog, with a small lake located in the southern portion. To complicate matters, the peat was so saturated with water that soil explorations could not be made because the ground was too soft to support a man's weight.

Another challenge was limited access to the range. Because the range was critical to tank crew qualification firing, it couldn't be shut down entirely. To allow mission-essential use, a temporary firing schedule closed the range for construction from 0530 until 1100 each day.

The new road was constructed in accordance with the embankment profile design (Figure 2). First, quarry rock ranging from 200 millimeters (mm) to 500mm in diameter was placed directly into the peat, or, in the southern end of the range, into the small lake. The rock, loaded into 5- and 20-ton dump trucks with 2 1/2 and 5 cubic yard loaders, was hauled out to the construction site along the existing range and service roads. The trucks dumped the rock, which was then pushed into the lake or swamp with a D7 bulldozer.

Enough rock was dumped until a platform strong enough to support the bulldozer was built.

In portions of the road, the depth of the quarry rock was estimated to be 3 meters. The width of the quarry rock layer was 19 meters. While this could support a bulldozer, it could not stand up to extensive wheeled vehicle traffic. Also, the depth of the quarry rock was not sufficient to reach competent strata, and deflections of up to 25 centimeters (cm) could be observed as equipment worked on the layer. This resulted in the nickname "floating road," because the quarry rock "floated" in the peat.

As the quarry rock was placed, the existing peat infiltrated the rock, saturating it to the elevation of the swamp. When enough quarry rock was placed to bring the grade above that of the swamp, a leveling course of 80-150mm stone was emplaced. Again, this was hauled in dump trucks and spread with bulldozers. On top of this was placed a 5 to 10cm layer of fines and overburdens, taken from a nearby borrow pit using a 621B scraper.

The fines and overburdens were graded and smoothed out, and a geotextile filter fabric was placed on the emerging road. This material is a woven fabric designed to allow water to pass through it but to prevent fines from the existing subgrade from working up into the overlying layers of aggregate.

The fabric was rolled out, cut into sections, and hand placed length-wise across the road. A 30cm lift of 0-32mm rock was placed on top of the filter fabric. This was hauled in by dump truck and pushed out onto the fabric with a Fiat Allis FD-5 landscaping bulldozer. On top of this was placed a woven geotextile mesh fabric that provided additional strength and

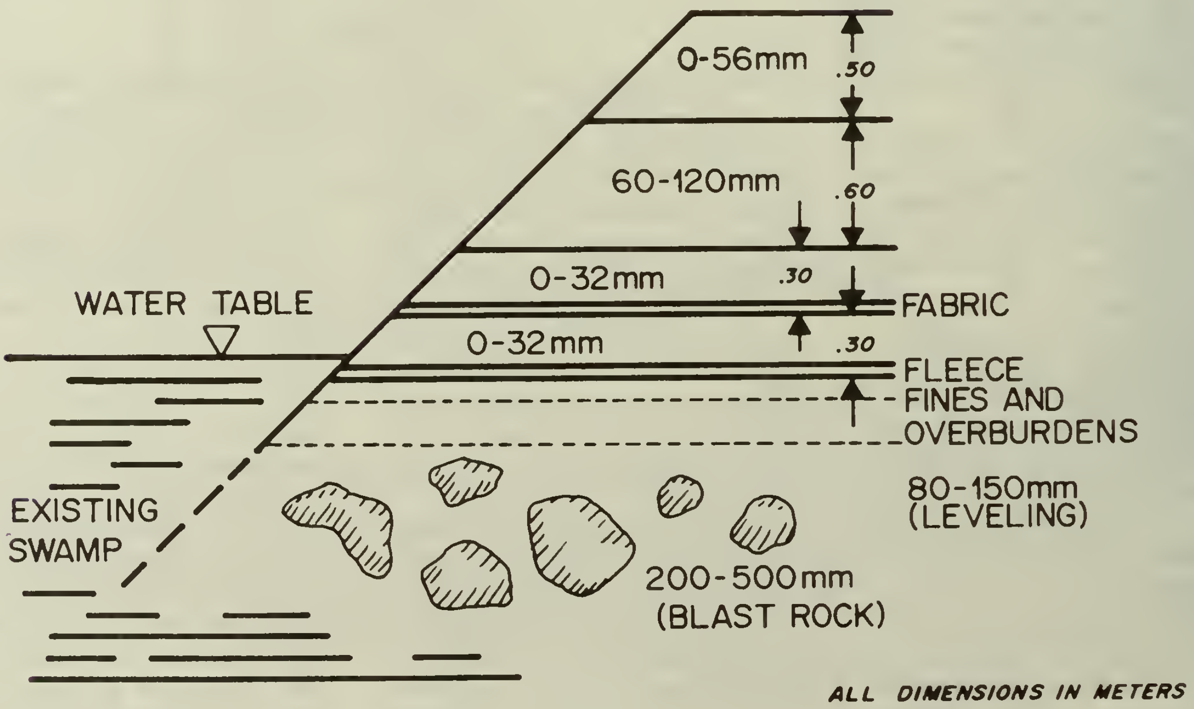


Figure 2

Engineers from Bravo Company, 79th Enginer Combat Battalion (Heavy), place geotextile on the "floating road" at Grafenwoehr Training Area, West Germany.

stability. Another 30cm lift of 0-32mm rock was then placed on top of the geotextile fabric.

This entire depth of rock served as a working platform of improved subgrade on which the sub-base, base course, and wearing course would be placed. The function of the improved subgrade was to support the construction traffic needed to build the sub-base course and wearing surface layers.

The "floating" nature of the road was readily observable, and deflections of up to 10cm could be seen as the 621B scrapers and 20-ton dump trucks traveled on the improved subgrade.

The effectiveness of the design was sound, however, because the deflection occurred over a wide area. Rutting of the subgrade was almost nonexistent because the load was transferred over a wide area and a large section of the road deflected in an elastic manner.

On top of the "working platform," or improved subgrade, a base course was placed consisting of a 60cm lift of 60-120mm aggregate. This rock was hauled and spread by 621B scrapers in 15-20cm lifts. The aggregate was smoothed by graders and compacted with vibratory rollers.

The final phase of the floating road project, currently underway, includes placement of base and wearing courses that consist of a 50cm lift of 0-56mm rock. This will be placed in 15-20cm lifts and compacted. Construction of concrete turn pads, culverts, and defilade firing positions is included in the final phase.

The use of a troop construction unit to complete the project proved to be a good decision. The unit adapted well to difficult conditions and a short on-site work schedule, and built a quality project at the lowest possible cost.

This project vastly improves scarce tank gunnery facilities for U.S. combat forces in Europe and avoids expansion of existing training areas.

Captain Pease is Commander of Bravo Company, 79th Engineer Combat Battalion (Heavy), 18th Engineer Brigade. His previous assignments include Civil Engineer, 79th Engineer Combat Battalion (Heavy); Maintenance Officer, 18th Engineer Brigade; MCA Project Manager, DEH, Fort Drum, New York, and Platoon Leader and Executive Officer, 76th Engineer Combat Battalion (Heavy), Fort Drum. He holds a B.S. in Geological Engineering from the Colorado School of Mines.

THE COLD, HARD FACTS ON *CLASSIFYING ICE*

By Captain Chris Sultemeier

As any military leader will tell you, time can be your best friend—or your worst enemy.

In an age of increasingly advanced and mobile military vehicles, the pace of any future conventional war will likely be fast and furious. Units halted by natural obstacles—not to mention those placed by the enemy—will become quick target opportunities.

The European theater has been the winter graveyard of many an otherwise capable army. It would provide perhaps the likeliest location for cold weather combat in any future conflict that may involve the U.S. Army. And for the inevitable cold weather river crossing operations, it would pose an uncommon challenge for field commanders.

While all maneuver and combat support commanders are familiar with standard bridging operations, few have experience or training in ice bridging.

A similar lack of experience with ice bridging may have foretold the winter disasters that lay ahead of the German Army as it pursued the retreating Russians in the early days of World War II. Generaloberst Halder, Chief of the German Army General Staff, wrote:

> *"The supply and railway situation east of the Dnieper was extremely critical during the winter of 1941-1942, since the withdrawing Russian troops had destroyed all bridges across the river. At that time, only makeshift bridges could be constructed, because many months would be required to build bridges strong enough to resist the pressure of high water....In order to obtain a railway bridge in the brief time available, it was decided to build an ice bridge....The complete lack of any experience on the part of all competent German agencies was a characteristic of its construction."*

While the German railway ice bridge over the Dnieper was completed in only 12 days, it took three weeks of computations and planning before construction actually began. Because the Germans had little knowledge and no experience of ice bridging operations, they lost precious time—and suffered an unnecessary delay in their bid to destroy the retreating Russians.

In today's U.S. Army, we face a similar lack of training. With the exception of the 6th Infantry Division (Light) in Alaska, the Army has negligible ice bridging training or experience.

And as our mechanized forces get faster, the vehicles are getting heavier. In a cold weather environment, ice bridging is a very real possibility for both forward combat units and the support trains. Because of this, every engineer officer and NCO should have a working knowledge of determining the capacity of ice to support river crossing operations.

Perhaps the most difficult question faced by engineers in determining the feasibility of ice bridging is how to determine whether the ice at a potential river crossing site is strong enough to support the expected vehicle traffic. Many competing factors, including temperature, velocity of the underlying stream, foreign matter and air voids in the ice, have a direct impact on the strength of the supporting ice.

Fortunately, there has been some research—both scientific and through the "school of hard knocks"—and formulas for computing the load-bearing capacity of ice are available.

For crossings where the temperature has been consistently below -10 degrees Celsius (14 degrees Fahrenheit), the Cold Regions Research and Engineering Laboratory (CRREL) formula should be used as the engineer's standard computation method:

$$h = 11\sqrt{P_t}$$

$$h = 12\sqrt{P_w}$$

h = thickness of ice in centimeters

P_t = weight of track vehicles in tons (2000 lbs)

P_w = weight of wheeled vehicles in tons (2000 lbs)

Other formulas have also been used for this extreme cold weather condition. During their construction of the Dnieper River ice bridge, the Germans developed their own capacity/design equation:

$$h = 13\sqrt{P}$$

Current Soviet doctrine uses the following equations for ice bridging:

$$h = 10\sqrt{P_t}$$

$$h = 12\sqrt{P_w}$$

h = thickness of ice in centimeters

P_t = weight of track vehicles in tons (2000 lbs)

P_w = weight of wheeled vehicles in tons (2000 lbs)

An engineer officer at the U.S. Army Engineer School, CPT James Langan, used the Plate Theory approach to develop an independent equation. The results of his analysis were very similar to the formulas already in use, and thus reinforce current doctrine:

$$h = 7\sqrt{P_t}$$

$$h = 8.3\sqrt{P_w}$$

All of these equations apply to ideal conditions where there is no debris or large air pockets in the ice, and the temperature has remained below -10 Celsius for a long period of time (10 to 14 days). Often these conditions are not present and reduction factors must be applied to determine the capacity of the ice.

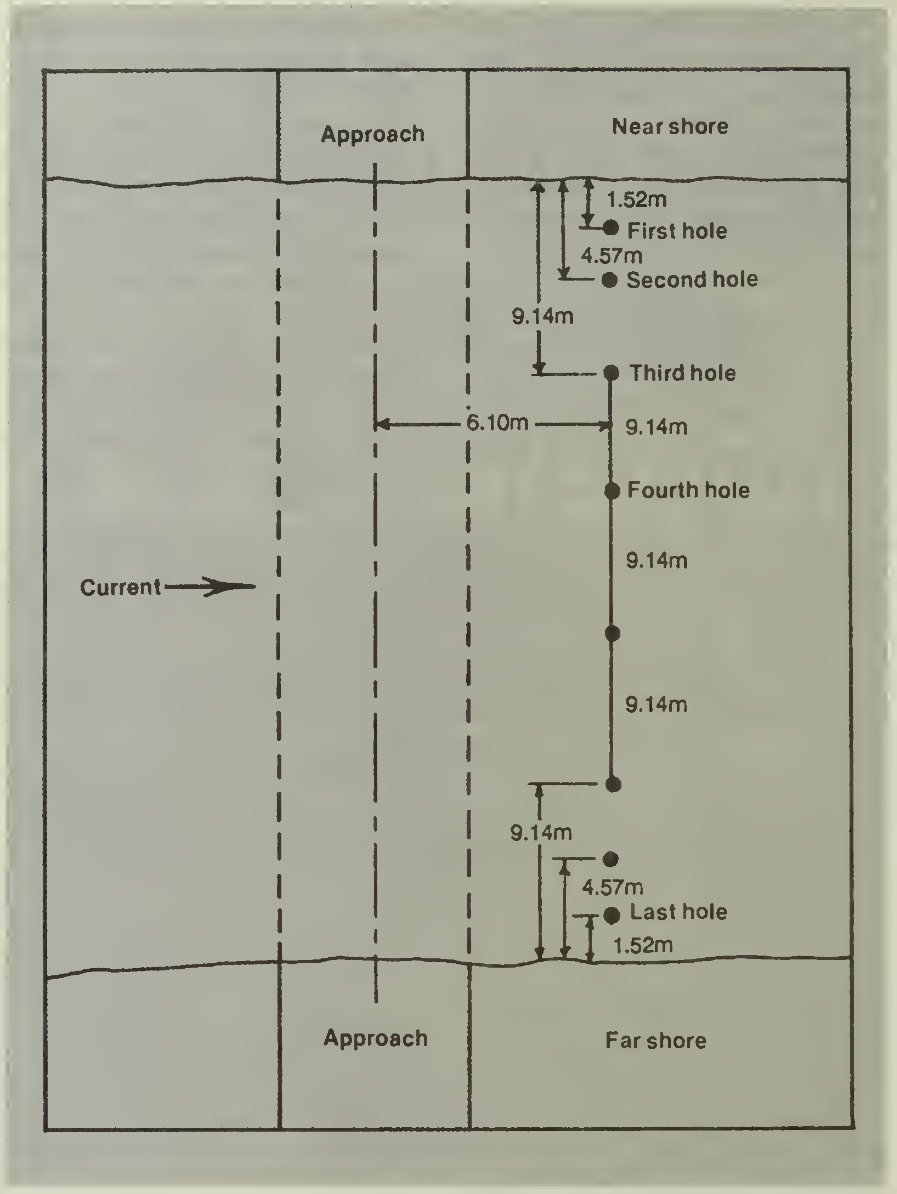
The U.S. Army's most experienced ice bridging unit, the 6th Infantry Division (Light), uses the following specific reduction factors for both strength and color.

Strength factor

- Ice is solid, temperatures have remained at or below freezing for the previous week; s = 1.0
- Ice is solid, temperatures have been above freezing during the day, but drop below freezing during the night; s = 0.9
- Ice is solid, water is running on the ice surface from runoff or overflow; s = 0.7
- Ice is not solid, water or airpockets are found between layers of ice; s = 0.7
- There is an air pocket under the ice, so the ice is not floating on the water underneath; s = 0.6

Color factor

- Ice is clear (transparent or black color); c = 1.0
- Ice is semi-clear (contains both transparent black and white layers of ice; c = 0.9
- Ice is white (snow mixed with ice); c = 0.8
- Ice is discolored (stained brown or yellow); c = 0.7



The 6th then applies these factors to their capacity equation, which is very similar to the ones already discussed:

$$h = \frac{11.3\sqrt{P_t}}{(c)\quad(s)}$$

$$h = \frac{12.7\sqrt{P_w}}{(c)\quad(s)}$$

c = color factor

s = strength factor

Because all equations begin with ice thickness, the above chart shows the locations for measurement. It is important that the proposed centerline be no closer than 100 meters from the edge of open water. Open water is defined as the location where the ice is 50 percent as thick as the ice near the centerline.

We must increase safety margins if a high volume of traffic is expected. Also, vehicle spacing must be no less than 100 times the thickness of the ice.

Let's take a hypothetical situation as an example of how to apply one of these formulas:

You are the platoon leader/task force engineer in a combat engineer battalion. An armor battalion commander has requested that you determine the feasibility of crossing a nearby river. The heaviest vehicles within the maneuver battalion are M1 *tanks. From your reconnaissance, you determine that the ice is white and appears to be solid. The temperature has been above freezing during the day. How thick must the ice be to support the maneuver battalion's crossing?*

From FM 5-36, *Route Reconnaissance and Classification*, an M1 tank weighs 60 tons.

Because of the color of the ice and the varying temperature conditions, the reduction factor formula from the 6th Infantry Division (Light) provides the most reliable answer:

$$h = \frac{11.3\sqrt{P_t}}{(c)\quad(s)}$$

$$h = \frac{11.3\sqrt{60}}{(0.8)\quad(0.9)}$$

$$h = 121.6 \text{ cm}$$

$$h = 47.5 \text{ inches}$$

Commanders and S-3s should include simulated ice classification exercises when planning field training—even during the hottest weather. While most units may not have the opportunity to conduct such training under realistic cold weather conditions, all engineer leaders should practice the application of these ice classification formulas.

Because on the modern battlefield, if you do not know how to ensure a safe ice crossing for maneuver elements, time may be your worst enemy.

Photo by Steve Miller

(Above) Armored personnel carriers from the 172nd Infantry Brigade prepare to cross an ice bridge over Alaska's Tanana River during Exercise Brim Frost. (Below) Soldiers from the 47th Enginer Company work on a water pump being used in an ice bridging operation.

Photo by Scott West

Suggested Readings:

1. *"CCREL Notes for the Winter Battlefield,"* U.S. Army Corps of Engineers, Cold Regions Research and Engineer Laboratory, Hanover, New Hampshire, April 1985.

2. *"Ice Railway Bridge Over the Dnieper,"* Hauptman Ludwig Schmeller, Foreign Military Studies, F-3431, Historic Division, U.S. Army Europe, 1953.

3. *"Floating Bridges, Ferry and Ice Crossings,"* Telov and Kanokov, published by the Soviet Department of Transport, Moscow, translated by the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia, August 22, 1978.

4. *"Evaluation of Ice-Covered Water Crossings,"* Arnold M. Dean, U.S. Army Cold Regions Research and Engineering Laboratory, Hanover, New Hampshire, June 1980.

5. *"Ice Bridging: The Plate Theory Approach,"* Captain James E. Langan, U.S. Army Engineer School, Ft. Belvoir, Virginia, January 20, 1987.

6. *"River Crossings, Soviet Style,"* Lieutenant Colonel William P. Baxter (Retired), ARMY, July 1980, pp 39-41.

7. *"Squad Leaders Guide for the Construction of Ice Bridges,"* 172nd Infantry Brigade, PAM 350-11, Headquarters, 172nd Infantry Brigade, Ft. Richardson, Alaska, November 8, 1985.

Captain Sultemeier most recently served as the Non-Standard Bridging Instructor for the Engineer Officer Advanced Course at Fort Belvoir. Previously he served in engineer assignments with the 1st Infantry Division at Fort Riley. He received a B.S. degree from the United States Military Academy.

DUST INITIATORS: Getting a *charge* out of flour

By First Lieutenant David N. Flint

> **"The explosion lifted the roof approximately 5 feet and the walls collapsed inward."**

While your mother may have used flour for cakes and cookies, combat engineers use it in a recipe for destruction.

"Dust initiator" charges, which combine small quantities of explosives with common powdered materials like flour, are specialized demolitions particularly suitable for destroying thin-walled, wooden buildings or railroad boxcars.

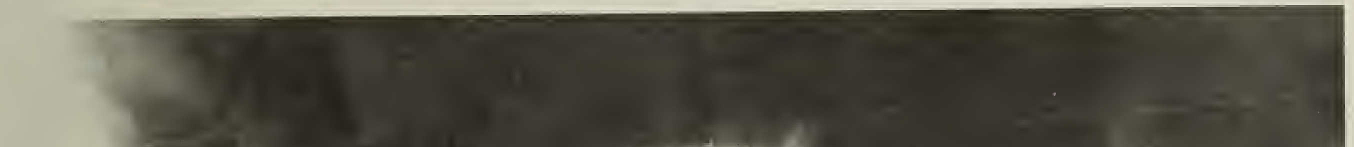
The 19th Engineer Battalion at Fort Knox, Kentucky, was recently given the job of demolishing a World War II era movie theater. The 300,000 cubic foot building was one of several aging buildings designated by Fort Knox officials for removal. Because of the large size of the theater and the close proximity of nearby buildings, the more traditional methods of demolition, such as dismantling or burning, were deemed inappropriate.

Dust initiator charges are described in FM 5-25, *Explosives and Demolitions*, as a "...concentrated charge equal to one-quarter to 1 pound of explosives per cubic yard of volume." The charges are constructed by mixing crushed TNT with thermite, which consists of two parts aluminum powder and three parts ferric oxide (rust). The crushed TNT and thermite are mixed together in a bag at a 1:1 ratio, and then primed with an Uli knot.

The bag is then placed on the ground floor of the building, and a cover material such as flour is poured on top of the charge. A 1-pound dust initiator charge (one-half pound of TNT and one-half pound of thermite) is capable of igniting up to 40 pounds of "finely divided organic material," such as flour. Other suitable materials include coal dust, cocoa powder, powdered coffee, tapioca, and powdered soap. The charge can be detonated either electrically or non-electrically.

These charges are most effective in an enclosed area with relatively few windows. The simultaneous explosion of the TNT and thermite distributes the "cover" (in this case flour) throughout the building and then ignites it. This causes the roof of the structure to raise 3 to 5 feet, the walls to collapse inward, and the roof to fall back down on the

(Above) The World War II-era movie theater at Fort Knox, Kentucky, as it appeared before demolition with dust initiator charges. (Below) The result of the explosive power of 23 flour-based charges.



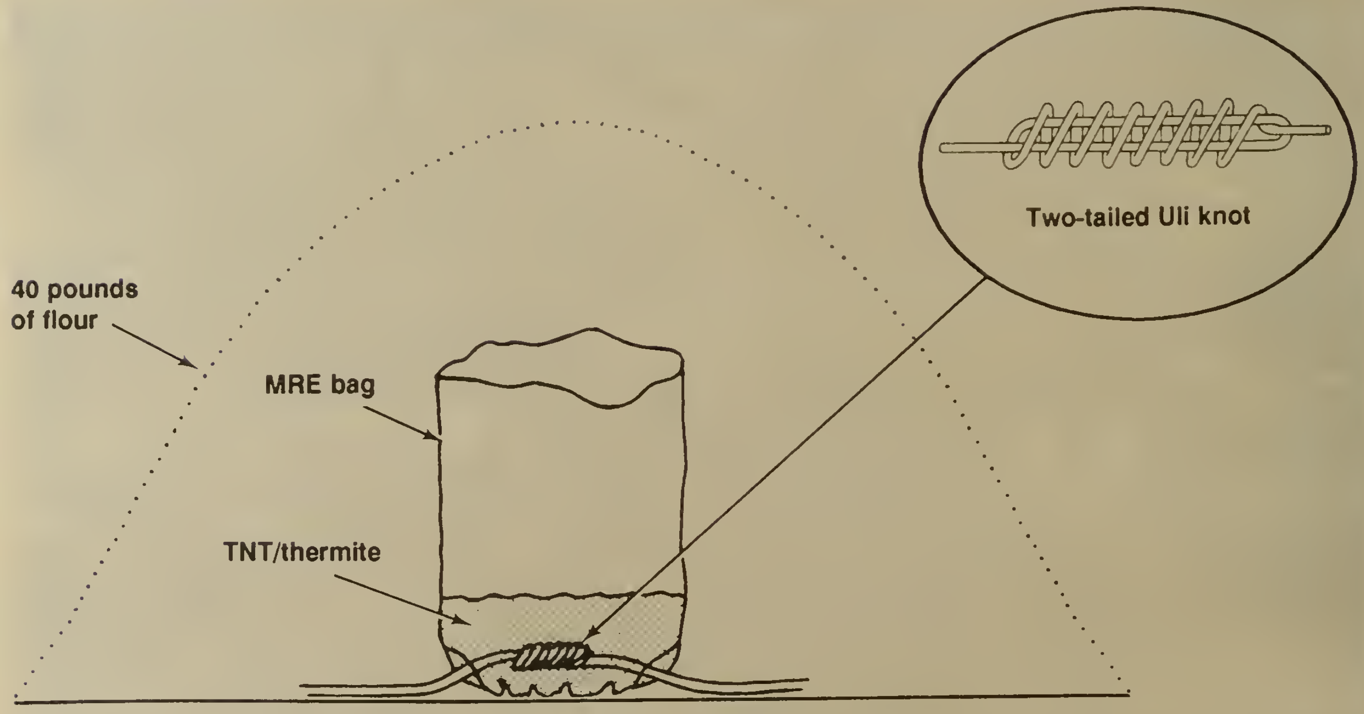
now-collapsed building. Debris from such an explosion typically is discharged only 30-50 feet from the demolished building.

The demolition of the movie theater using dust initiator charges was unusual because the structure was so large. The wood-framed walls were reinforced with large timber columns, 13 inches by 13 inches, spaced 15 feet apart along the two side walls. On either side of the building, a number of interior walls formed small rooms which had once been used for rest rooms, ticket booths and storage rooms. In order to allow the cover material from the charges to disperse evenly throughout the building, the sheet rock from most interior walls was removed prior to the demolition. The 2-inch by 4-inch studs were left in place.

As a test measure, the interior walls of three small rooms were not removed. The doors to these rooms were closed and no charges were placed inside. The rest of the building was prepared for the demolition by placing 3/8-inch plywood over glass doors and the windows to help make the building airtight.

The size and number of charges needed to destroy a building depend on the amount of cover material needed, which is calculated using the volume of the structure. The calculation formula is 3 to 5 pounds of cover for each 1,000 cubic feet, using 3 pounds for enclosed buildings and 5 pounds for partially enclosed buildings. The movie theater was enclosed, so 900 pounds of cover was required. A 1-pound dust initiator charge will detonate up to 40 pounds of cover material, so the theater demolition required 22 1/2 1-pound charges. For convenience, 23 charges were used.

The charges were constructed by first cutting a 1-pound block of TNT in half. The soldiers placed a one-half block of TNT into an MRE bag and crushed it with a face hammer (a non-sparking hammer is required for safety). The cardboard container holding the TNT was used as a measure to pour an equal amount of thermite into the MRE bag. The TNT and thermite were thoroughly mixed together to form a 1-pound charge. Another MRE bag, which would hold the final charge, was prepared by cutting off the two bottom corners to provide holes just large enough to slide detonating cord through. Rather than use a standard Uli knot, which would only allow the charge to be single fired, the Uli knot was tied in the center of a 10-foot branch line, as shown below. Each end of the detonating cord was placed through the holes in the MRE bag, and the Uli knot was centered inside the bag. Tape used to close the holes in the bag was then wrapped around the detonating cord. The TNT/thermite mix prepared earlier was then poured into the bag.



Soldiers placed the bag on the floor of the building, and poured 40 pounds of flour onto each charge. This procedure was repeated 23 times so the charges were evenly spaced throughout the building. Each charge was connected to two separate firing systems. Non-electric caps were then connected to each of the firing systems.

The demolition of the theater went as planned. The soldiers pulled the fuze igniters, and walked to a covered position 200 feet away. The explosion lifted the roof approximately 5 feet and the walls collapsed inward. Debris from the building was scattered 30-50 feet away from the building. Several of the 13-inch by 13-inch wooden columns were still upright, but they leaned inward at a 60-degree angle. A small fire started approximately three minutes after the explosion, and it was allowed, under the supervision of the fire department, to consume the debris.

The three small rooms which had no charges placed inside them were still intact, although they burned rapidly. The buildings adjacent to the explosion suffered no damage. The well-controlled nature of the explosion was shown by a street lamp which, although only 25 feet from the building, remained unbroken.

The theater demolition project at Fort Knox demonstrated the effectiveness of the dust initiator technique and its specialized military applications. The engineers who carried out the job proved their skill in explosive techniques, while learning that flour can indeed be an important ingredient in the recipe for destruction.

Lieutenant Flint is currently a platoon leader in the 522nd Engineer Company, 19th Engineer Battalion, 194th Armored Brigade, Fort Knox, Kentucky. He previously served with C Company, 19th Engineer Battalion. He is a graduate of the Engineer Officer Basic Course.

(Personal Viewpoint continued)

soldier like other munitions.

The mandated 30-minute wait before inspecting a misfire is not possible in combat. What factors went into specifying this time delay? How long can a defective fuse sputter and smolder and still burn to the cap? What confidence level must we achieve and how long must we wait to achieve it? What is the probability of both fuses in a dual primed system being defective?

We must establish a waiting time for dual-primed charges with 2-minute fuses. I have never had a dual-primed charge fail to detonate on schedule. If analysis indicates that dual priming is not reliable enough, triple priming should be the rule.

Our minimum allowable safe distance from one-half pound of explosive is 300 meters. 1000 feet! This safe-distance rule is designed to eliminate missile hazard over a smooth plane. It is not designed for combat or realistic training environments where soldiers use folds in the ground or APC armor for cover. If we applied this number to all explosives, we could not fire a LAW, throw a hand grenade, or detonate a Claymore.

Dupont's *Blaster's Handbook* states that a conservative blast safety distance from one-half pound of explosive is 22 feet. We use a distance 50 times larger! Excessive safety distances lead to unsafe situations because soldiers ignore them. Accident risks rise because soldiers don't know the true hazard distance.

Over-Water Procedures. Current over-water safety procedures are band-aids that cover real safety problems. All 12C bridge crewman and 12B combat engineers should be swimmers. We should incorporate swimming into their PT programs and make it an MOS-qualification requirement. A high percentage of 12Cs should be lifeguard-certified. Medics supporting bridging should have resuscitation equipment. All bridge-erection boats should have permanently installed life preservers with attached ropes and boathooks in ready-use racks. We should practice man-overboard drills every time a boat is put in the water.

Why not assign buddy-team responsibilities for troops working over water, so that nobody could fall in the water without being missed? The Boy Scouts figured this one out long ago.

We must consider the total threat to troops working over water, including threats caused by the enemy. Raft and boat crews must have their individual weapons available and wear combat equipment. If we purchase proper life jackets for the force (class 5), soldiers could wear web gear and carry a slung weapon. Adding a grenade pull ring to the helmet chinstrap would give it a quick release. Because rafts and bridges are priority artillery and air attack targets, we should routinely protect bridge boats against fragments with sandbags around the crew positions.

Training. The most important safety procedure is to build a well trained force. Nothing is more unsafe than allowing a force of amateurs to undertake complex, potentially hazardous tasks, especially when everyone's safety depends on each person knowing their job.

We must not avoid training a critical combat task in peacetime because of potential hazards. Training to standard in a controlled environment is the only way to surmount the hazards. If the task is unsafe, change it. Don't prohibit it, fix it!

We must develop safe combat safety procedures, drill those procedures into habit, and set responsibilities at the correct level—not for safe training, but for true safety.

LTC Greenwalt, a combat engineer, is assigned as Chief, Tactics, Training, and Doctrine Division, Directorate of Combined Arms, U.S. Army Engineer School.

Engineer Problem

You are tasked to design a concrete mix for aircraft runway pavement. The following specifications and conditions apply:

- Required 28-day compressive strength (f'c): 4,000 pounds per square inch (psi)
- Exposure conditions: Extreme freeze-thaw and air-water exposure
- Cement (C): Type 1A (air-entrained)
- Specific gravity of portland cement (SGc): 3.15
- Slump range: 1-2 inches
- Maximum size aggregate (CA): 2 inches
- Specific gravity of coarse aggregate (SGca): 2.7
- Dry-rodded unit weight of coarse aggregate: 110 pounds per cubic foot (lb/cf)
- Specific gravity of fine aggregate (SGfa): 2.6
- Dry-rodded unit weight of fine aggregate: 105 lb/cf
- Fineness modulus of fine aggregate (FM): 3.0

Assumptions:

- Specific gravity of water: 1.00
- Weight of water: 8.33 pounds per gallon (lb/gal)
- Weight of one sack of portland cement: 94 lbs

Reference Manual: FM 5-742

Engineer Solution on page 44.

COMBAT ARMS PERSPECTIVE

Survivability

And the Tank Platoon Defense

Editor's Note: With this issue, ENGINEER begins a new feature designed to provide readers with expanded insight into combat branch operations, especially those pertaining to engineer missions. The following article originally appeared in the January/February 1989 issue of ARMOR Professional Bulletin. Original articles by other combat arms personnel are welcome.

by First Lieutenant Kevin Keaveny

Many tank platoons do not know how to prepare a defensive battle position. While the "book" states every tank platoon must correctly construct defensive fortifications, to find out just how to do this becomes a challenge. Worse, platoon leaders have difficulty understanding and integrating engineers into the defense.

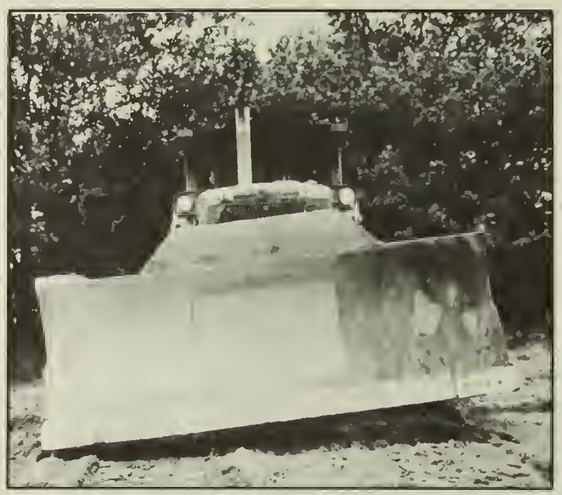
In the year and a half I served as an armor platoon observer controller at the National Training Center, not one platoon in thirty-three ever did all defensive tasks correctly. It always seemed a platoon was good at one point or another, but not at everything. This article discusses ways to overcome these deficiencies by methods employed successfully using tank platoons at the NTC. Points contained here address engineer organization, engineer equipment, fighting positions, listening and observation posts, and prestock ammunition sites.[1]

Engineer Equipment

Platoon leaders seldom grasp where the engineers come from, or what a monumental task it is to dig in a battalion task force.[2] The brigade normally goes to the field with an attached engineer company of the divisional engineer battalion, with subordinate engineer platoons under the operational control of battalion task forces.[3] In all cases, the engineers receive specialized logistic support from their parent unit, while the task force provides common class support. Additional engineers can come from division or corps on a direct or general, support basis. Many of these engineers do not normally dig in tanks, so platoon supervision must be exact.

D7s, D8s, ACEs, and CEVs are the four engineer vehicles associated with building survivability positions.[4] At the time of this article, D7s and D8s are the most numerous and provide most of the earth-moving power of the combat forces. The CEVs, found in the two CEV sections of the engineer company, are excellent for building posi-

Meet the Movers and Scrapers...



One advantage of the D7 and D8 bulldozers is the ability to tilt the blade to focus earth-breaking power, as seen here.

The CEV's blade is wider than its hull, hence it can excavate a full-width tank position, suitable for both M60s and M1 tanks, in a single pass.

The M9 Armored Combat Earthmover (ACE)

The M9's blade, like that on the D7, is narrower than a tank, so leaders have to ensure that the positions it excavates are wide enough for the tanks being emplaced. Each engineer platoon has only two of these.

tions but are used more for mobility and countermobility tasks.

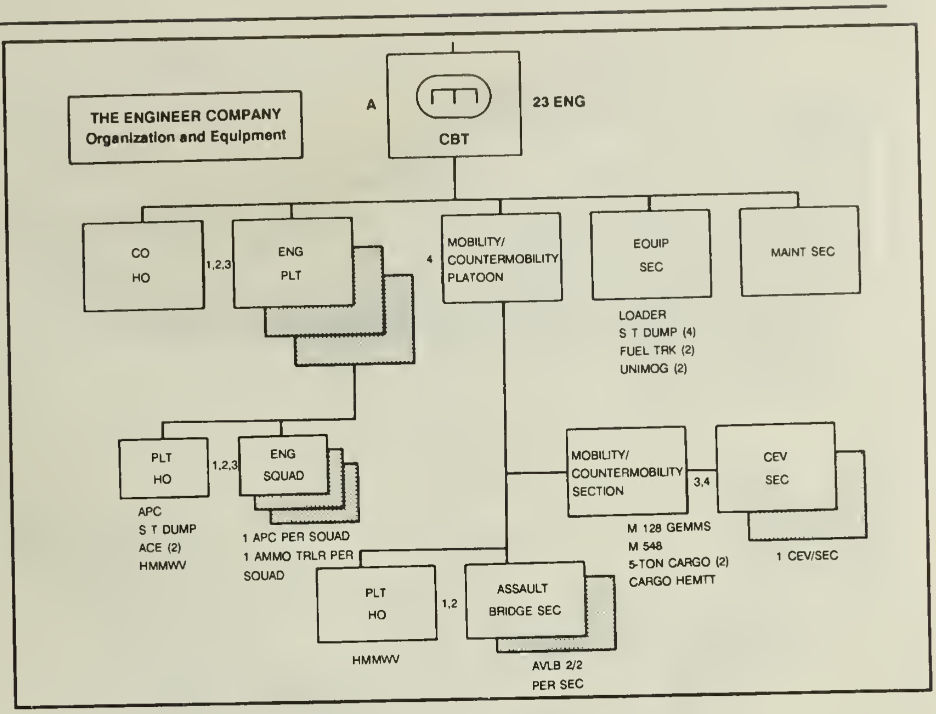
The blades on the tractors are hydraulically operated, and on D8s, and late-model D7s, are adjustable in the horizontal as well as the vertical plane. The ability to tilt the blade horizontally allows the operator to increase the surface pressure on either end, giving the tractor greater earth-breaking power. Supplementing the blade on some tractors are rippers, located at the rear of the vehicles, that act much like a backyard spading fork.

In an environment with extremely hard soil, a typical scene would show the tractor operator preparing the ground by dragging the rippers across first. Then, if required, he would tilt the blade to further break the soil. As a last step, the operator levels the blade and removes the remaining soil from the hole. The D7, though it looks like a D8, is actually smaller, as is its dozer blade.[5] This point is moot until one considers that both the M60 and M1 tank hulls are wider than the D7 blade.[6] This puts added pressure on subordinate leaders to ensure positions are wide enough for tanks to enter and exit without throwing track. The same blade size problem exists with the ACE, which mounts a blade smaller than the D7. There is no problem for the CEV to dig positions, because its blade is wider than its own hull, providing a snug fit for both the M60 and M1.

The platoon leader needs to understand that a battalion task force may only have hours to prepare a defense, and such time will not be sufficient to complete its engineer work.[7] As a case in point, an armor battalion task force, with an engineer platoon OPCON and allotted twenty-four hours to defend, faces many sobering facts:

- The engineer platoon has only two ACEs, for a maximum of 48 construction hours *(See figure on facing page)*.
- Forty-six combat vehicles require survivability positions.
- Position construction time will take from 46 hours for all-hull defilade to 119 hours for turret defilade positions.
- Mobility and countermobility tractor tasks, tractor down-time, operator availability, and travel time between positions will all subtract from survivability construction time.
- Each of the 12 platoons can only expect to see the tractors for up to four hours.

The platoon leader needs to decide beforehand what work the engineers will accomplish onsite. The platoon leader calculates how


THE ENGINEER COMPANY
Organization and Equipment

much time will be required to dig each fighting position, adds that time up, and compares the total to the time the engineers are under his control.

If the time required to dig in exceeds the engineer time available, one of three courses of action is possible:

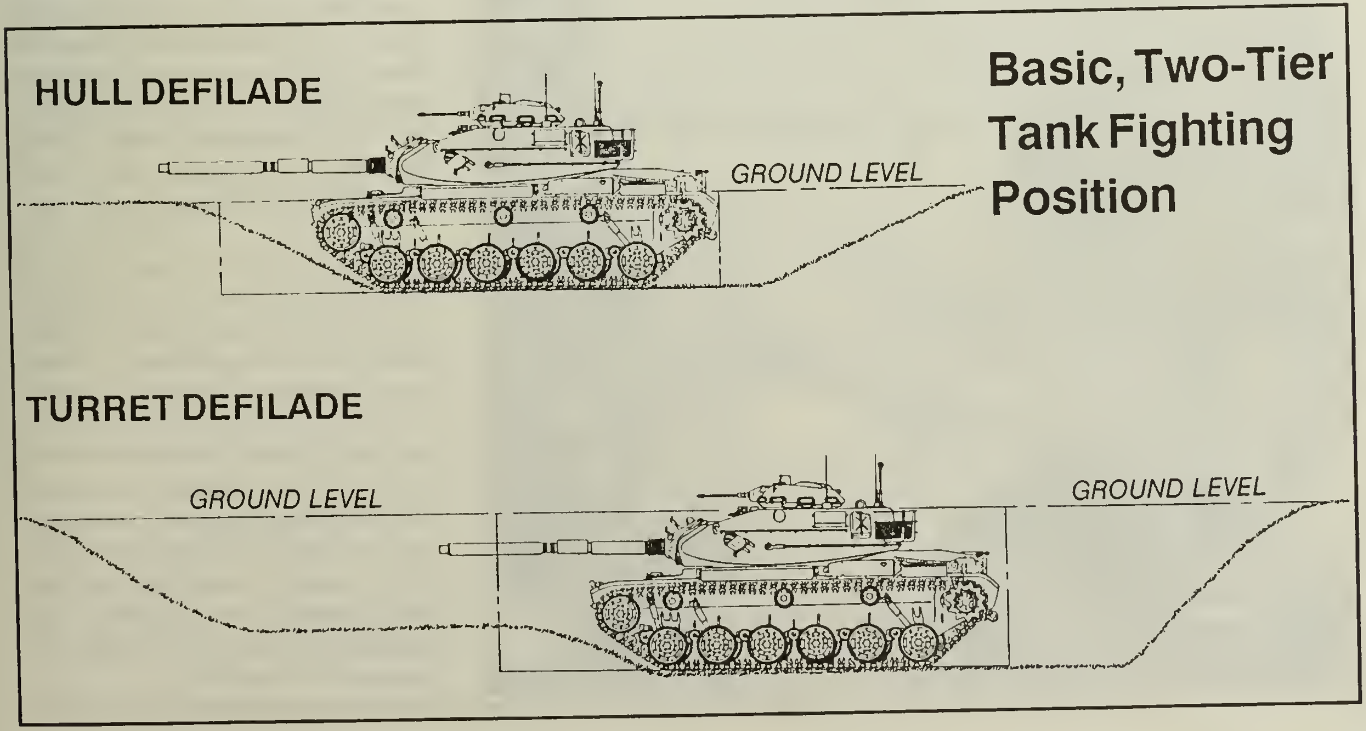
- Select new fighting positions requiring less construction time.
- Have more construction time allotted by the company commander or battalion headquarters.
- Request the assignment of additional engineer assets.

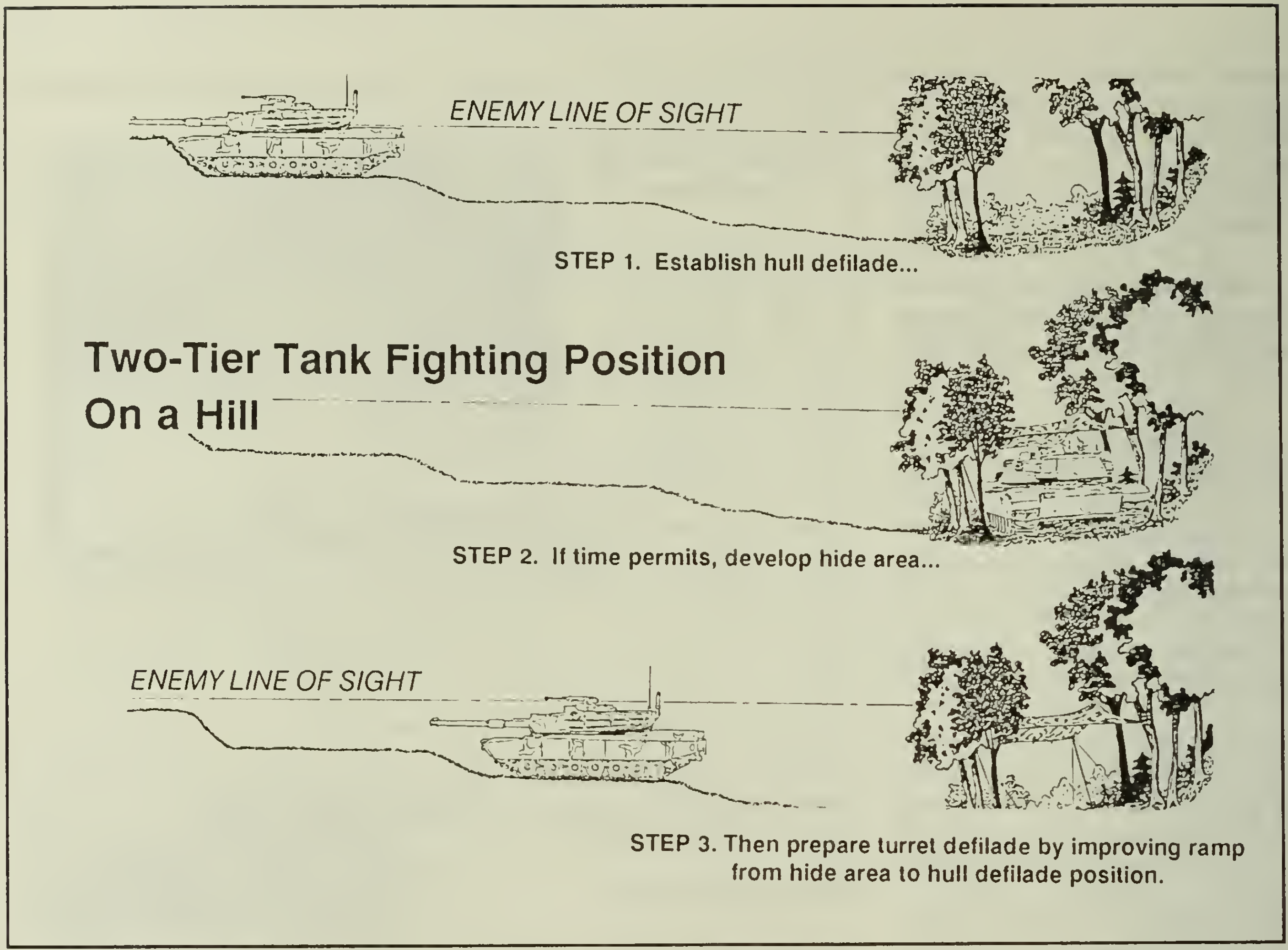
If extra time exists, use it to improve positions, dig in prestock ammunition, or loosen soil for listening and observation posts. As a backup to the first plan, leaders should also prepare a contingency plan, so if the engineers are able to return, they can improve the positions. Routinely, platoon leaders *underestimate* what the engineers can do the first time on the battle position. By not preparing for them the second time, platoon leaders cannot achieve the best possible defense.

Fighting Positions

Doctrinally, deliberate fighting positions consist of four elements constructed in this order: hull defilade, concealed access route, hide location, and turret defilade.[8] In the field, many platoons instead opt to build the positions in this order: hull, turret, access ramp (route), and hide. Experience shows that engineers seldom have enough time to improve hide positions.

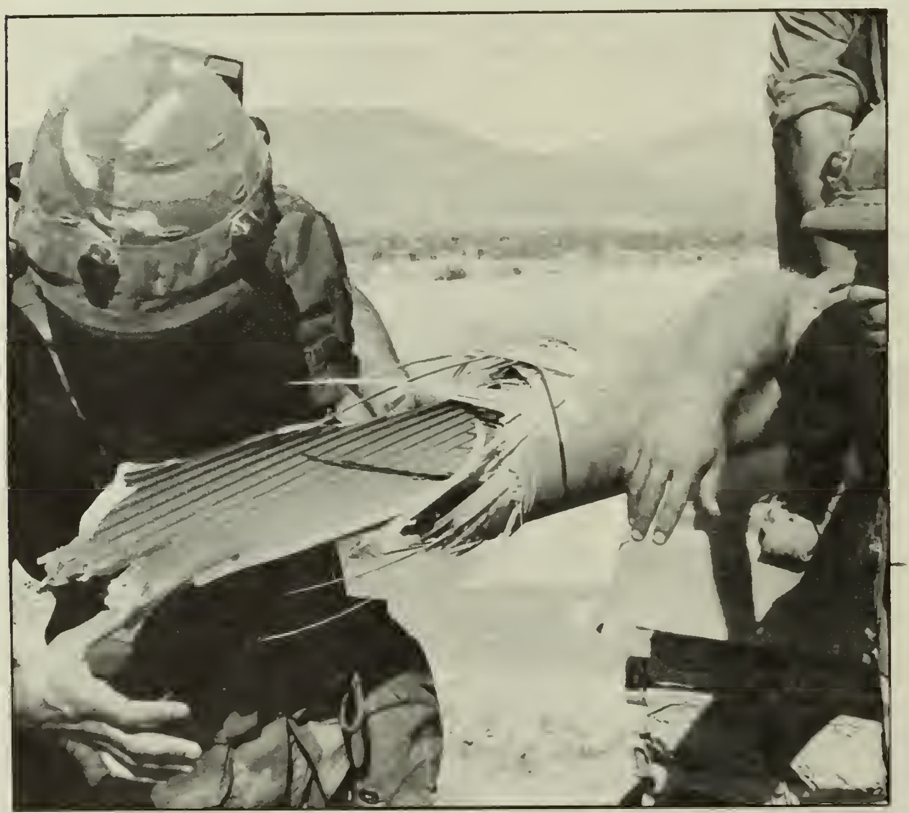
Also, contrary to doctrine, many units dig positions from *back to front,* leaving spoil piled into berms.


Basic, Two-Tier Tank Fighting Position


ENEMY LINE OF SIGHT
STEP 1. Establish hull defilade...
Two-Tier Tank Fighting Position On a Hill
STEP 2. If time permits, develop hide area...
ENEMY LINE OF SIGHT
STEP 3. Then prepare turret defilade by improving ramp from hide area to hull defilade position.

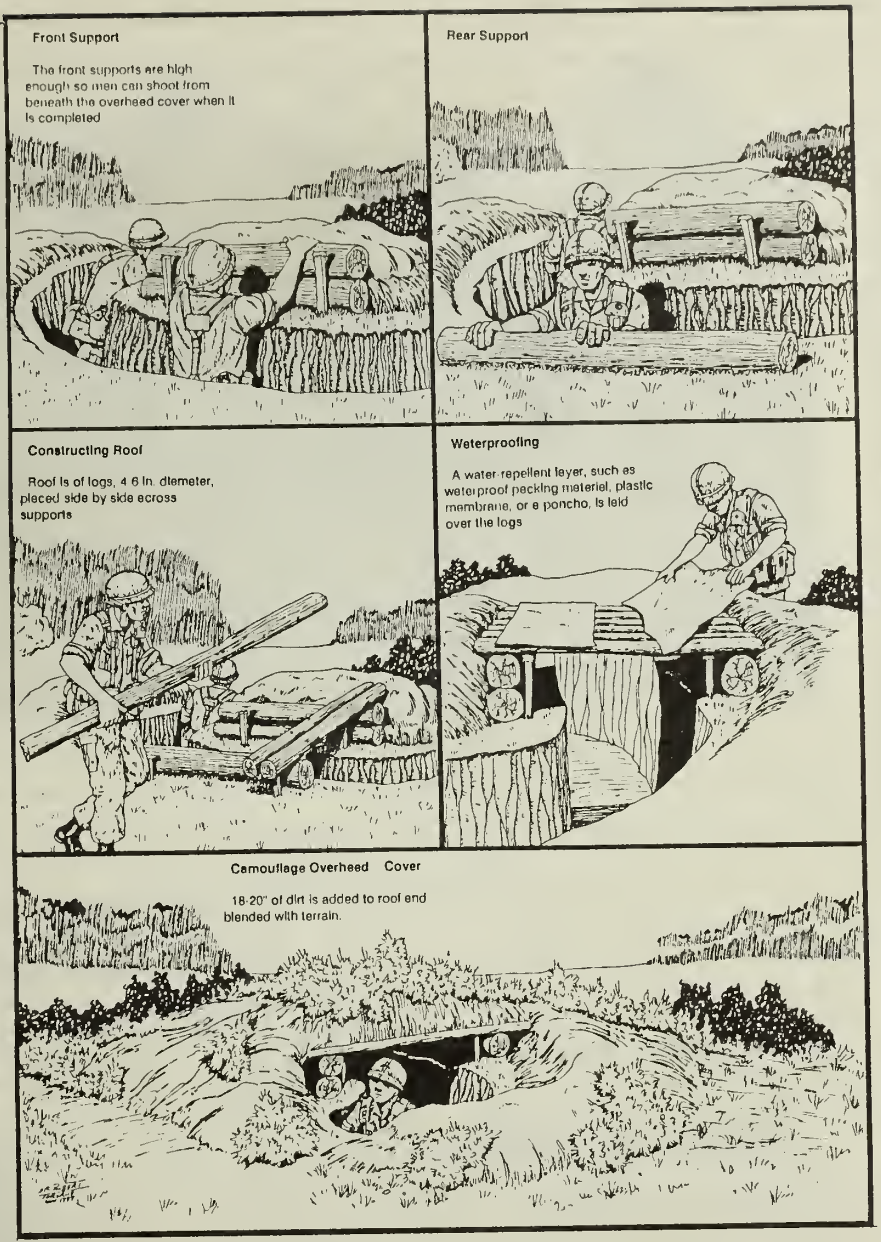
The unfortunate side effect of this method is that the disturbed earth usually reveals the position and enables the enemy to target friendly tanks with artillery and maneuver forces. While some can argue that hasty positions are better than nothing, such arguments weaken when the unit understands how little protection it is really getting.[9]

Whenever possible, units need to camouflage or haul away spoil. In cases where spoil remains, the leader needs to go forward of the battle position and look back to



In this case, the access ramp was too steep, and the tank commander failed to raise gun tube high enough when moving into hull defilade. As a result, dirt entered gun tube, and the tube failed when it was fired.

evaluate what the spoilage reveals, and then adjust his defensive plan accordingly.



Front Support

The front supports are high enough so men can shoot from beneath the overhead cover when it is completed

Rear Support

Constructing Roof

Roof is of logs, 4 6 in. diameter, placed side by side across supports

Waterproofing

A water-repellent layer, such as waterproof packing material, plastic membrane, or a poncho, is laid over the logs

Camouflage Overhead Cover

18-20" of dirt is added to roof and blended with terrain.

One- or Two-Soldier Position with Overhead Cover

While providing ideal protection for soldiers in listening posts and OPs, there is seldom enough time to prepare such a complex position. Prefabricated version on the following page protects as well with less digging.

Desert operations present unique problems for position construction. The earth is usually either too soft or too hard to permit conventional positions, so the platoon leader must seek a balance between the use of natural terrain and engineer-prepared positions.[10] Ravines, wadis, and dunes can all provide a certain amount of ballistic protection if located effectively within the battle position. When using natural fighting positions, the related protection is greatest at or near the main gun's effective range, but diminishes as the enemy closes and is able to maneuver against specific targets.

Individual Fighting Positions

Listening and observation posts need to withstand indirect fire. Tank platoons tend to violate this principle and send out soldiers to man posts that have no protection at all. As doctrine now stands, the only fighting position applicable is the one-soldier deliberate, with eighteen inches of overhead cover — not a good choice because most tankers dislike digging.

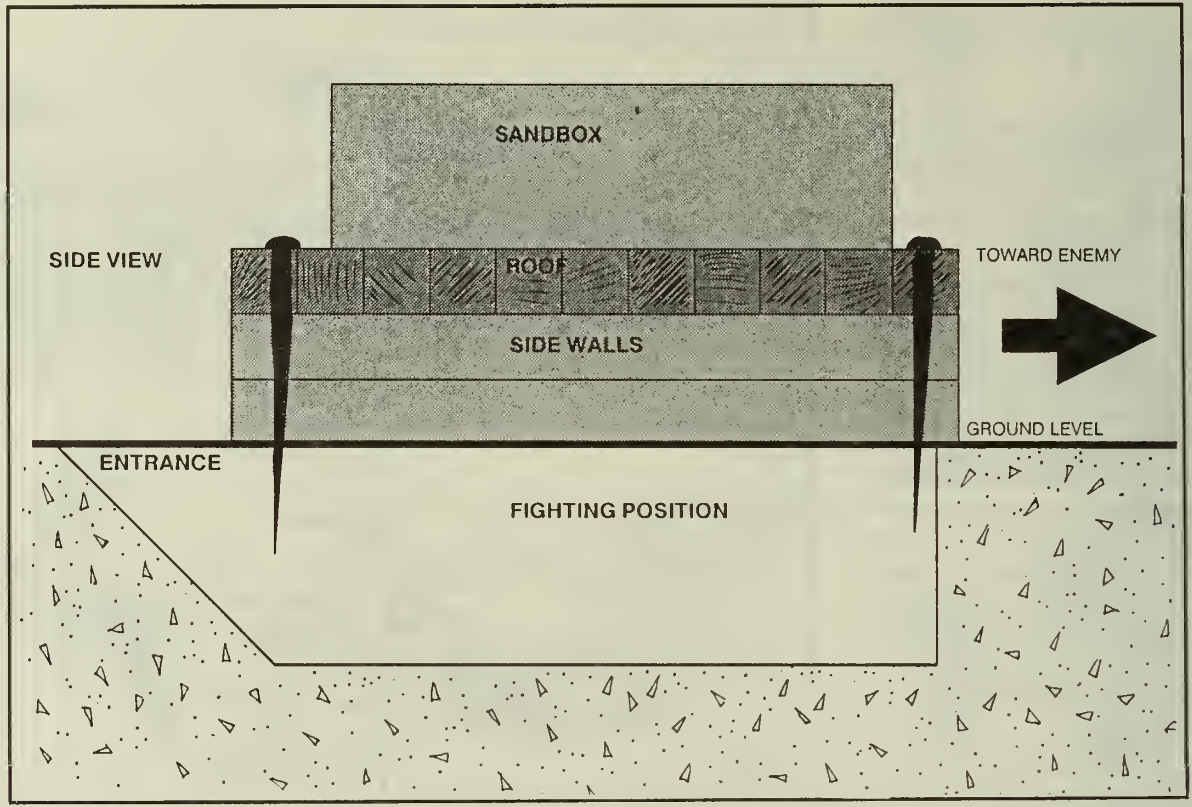
An alternative is to modify another position, the one-man hasty prone, into a deliberate with the same eighteen inches of overhead cover. Such a position lends itself to prefabrication.

To store the structure, a bracket mounted on the tank's bustle rack holds the folded roof.[11] Displaced tactical signs, formerly on the bustle rack, can either attach to the outside of the roof or appear directly on it. The design concept of the "deliberate" prone position has four key features:

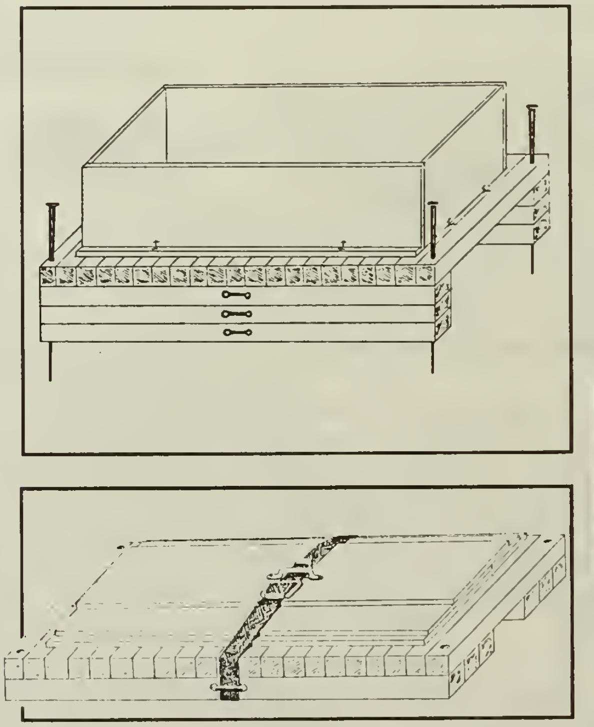
- It is foldable for storage.
- A pop-up sand box on top holds the eighteen inches of overhead fill.
- Four-by-four construction lends sturdiness.
- Spikes firmly anchor the roof into the ground.

Of the two positions, the "deliberate" prone has three principal advantages:

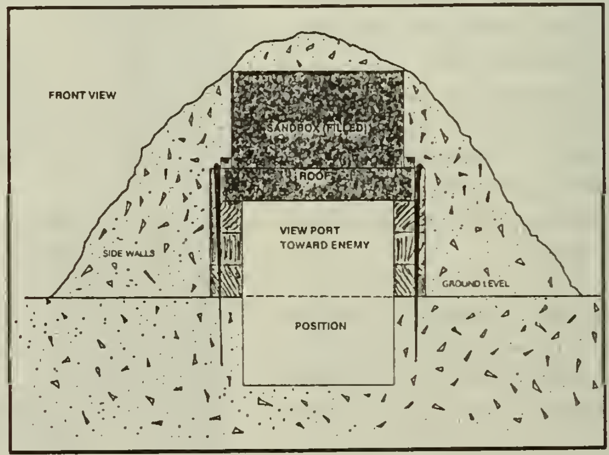
- The position requires the removal of 12 cubic feet less of dirt.
- The majority of the dirt is composed of loosely compacted top soil.
- A tractor can take a swipe of soil to eliminate much of the necessary digging.[12]



A Semi-portable, Modified Hasty One-Man Fighting Position With Overhead Cover



"Sandbox," roof beams, and side beams fold up and store on tank turret. When assembled and filled with earth, box adds 18 inches of overhead cover to roof.



At top and above, drawings illustrate how semi-portable overhead cover is assembled and buttressed with earth, both for camouflage and additional ballistic protection. "Sandbox" folds and stores on turret bustle brackets; spikes are stored in sponsons.

Excavators can loosen soil, even if there's not enough time to finish the job by machine.

Another survivability project is the task of fortifying prestock ammunition against indirect fire. More than any other task, some tankers view the job of hardening prestock sites as a distraction from other responsibilities. Two methods are available to cut down the time dedicated to hardening the sites. The first is to carry on the tanks – or in the trains – enough Class IV to support the required eighteen inches of overhead cover.

The second method, shown by field experience to be the best, is to use the wooden ammunition packaging crates filled with sand and soil. The crates are easy to stack, provide a handy method for building, and come with handles for easy access to the rounds beneath. Again, the engineers can assist by digging a slit trench, which places the rounds below ground level and provides loose soil for filling the crates.

Usable fighting positions, listening and observation posts, and prestock ammunition sites are critical to an armor platoon's defense. Platoon leaders must use engineers to help make the best possible defensive battle position. To do that, the platoon leader must define what tasks the platoon can do itself and what tasks the engineers can help with. As a minimum, the platoon leader is responsible for all site selection and post-construction evaluation. Subordinate leaders are accountable for supervision and doctrinal soundness of construction. With the right supervision from the tankers, and productive work from the engineers, the platoon will gain steady firing platforms, and a chance to dominate the battle.

Notes

[1] FM 71-1, Final Draft, Section Four, June 1983.

[2] Divisional Engineer Company TOE 5-145J, Divisional Engineer Battalion TOE 5-145J, Command Relationships FM 5-103, 2-29.

[3] Vehicular composition of a TOE 5-145J Divisional Engineer Company is six tractors, two combat engineer vehicles, and two small emplacement excavators.

[4] D8s are not common to divisional engineer battalions, but are used by other engineer elements which may appear in the forward battle areas.

[5] The D7 blade is 11 feet wide: the D8 is 13 feet, 1.5 inches; and the width of the M9 ACE blade is 10 feet, 6 inches.

[6] The M60 is 11.91 feet wide, the M1 11.98 feet wide.

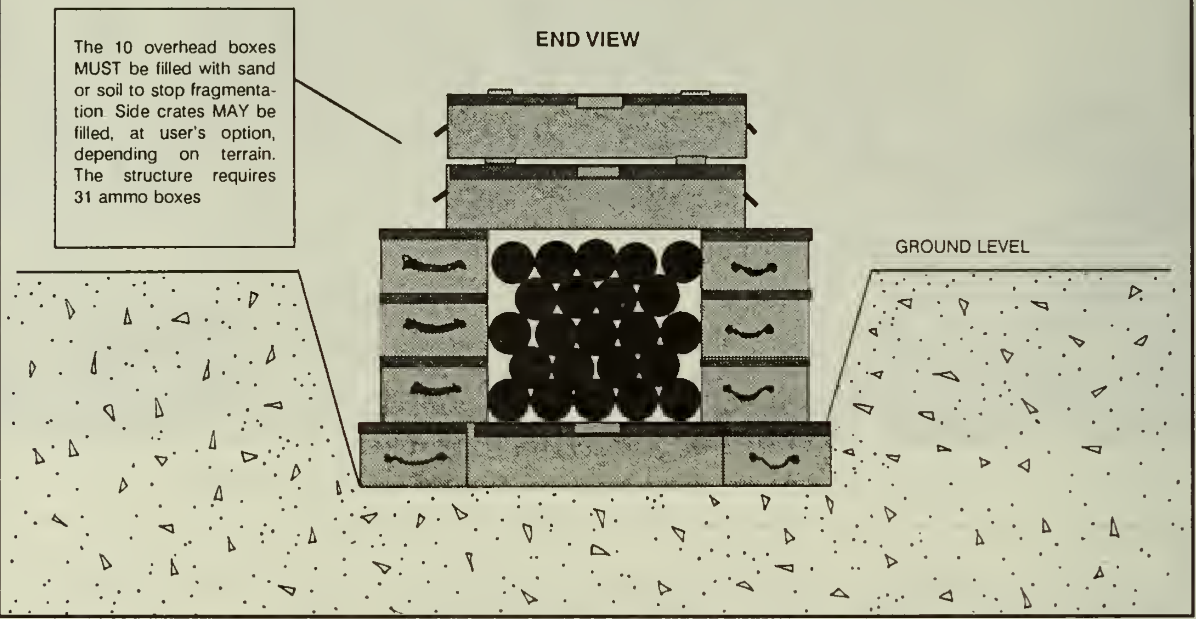
[7] FM 71-1, Final Draft, Section Four, June 1983, and FM 5-100, May 1984.

[8] No matter what any manual states as construction times, such numbers are only estimates. In many cases, there are differences between manuals.

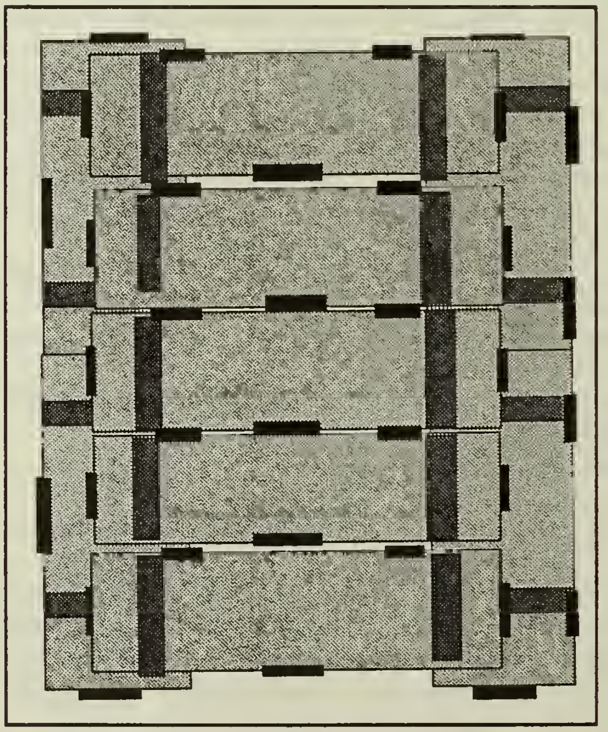
[9] Hasty positions are often referred to as MILES berms, parapets, or berms. FM 5-103, 4-13, states such positions are

Hardened Prestock Ammunition Site

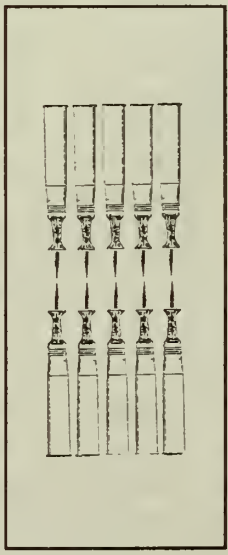
Constructed of ammo crates filled with sand, this ammunition shelter holds 54 tank rounds. A few dozer swipes prepare the hole. Spoil is used to fill crates.



The 10 overhead boxes MUST be filled with sand or soil to stop fragmentation. Side crates MAY be filled, at user's option, depending on terrain. The structure requires 31 ammo boxes



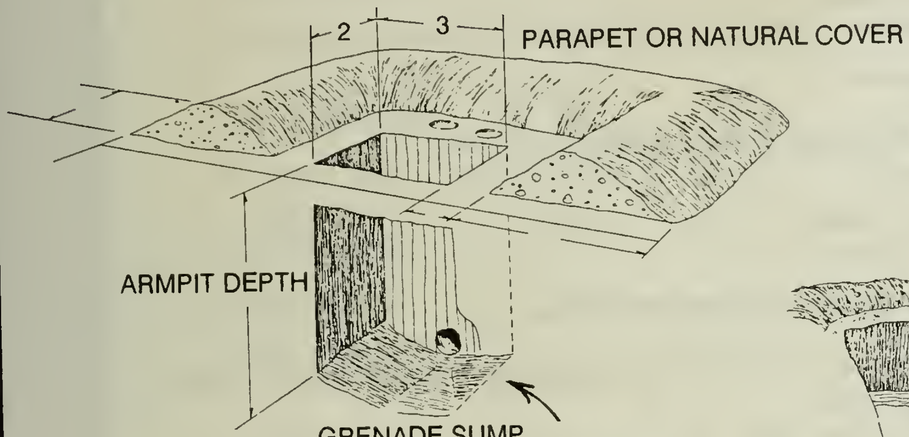
Increased Survivability For Prestocked Ammo

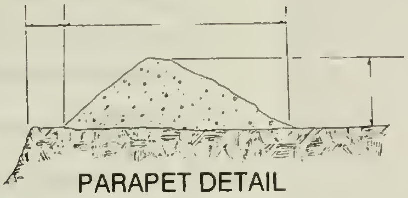


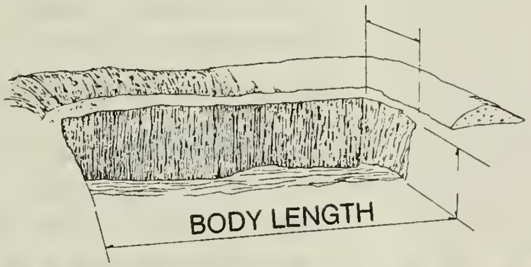
This field-expedient method protects main gun ammunition from indirect fire. The basic building block is the empty ammo crate, filled with soil taken from the slit trench excavation that allows the rounds to be stored below ground level.

At left, schematic shows how rounds should be stacked in the enclosure.

One-Soldier Position (Deliberate)







One-Soldier Position (Hasty Prone)

"usually for APCs and CEVs and are not recommended for tanks because of their false sense of security."

[10] FM 90-3, 4-6, elaborates on desert fighting positions, which consist of irregularly-shaped scoops approximately two meters deep in the center and three times the vehicle width.

[11] The mount would be similar, but not as complicated as the mounting developed in the late 1970s for the tank-mounted reconnaissance motorcycle.

[12] The one-soldier deliberate fighting position requires removal of 30 cubic feet of soil (3 ft. x 2 ft. x 5 ft.), compared with 18 cubic feet for the hasty prone position (6 ft. x 2 ft. x 1.5 ft.)

Battalion Task Force Emplacement Time

Chart illustrates how to calculate the time needed to emplace a heavy division battalion task force with a mix of M1 and M2 vehicles. (In an M60/M113-equipped force, there would be more dozer time available per tank because many units do not dig in hasty fighhting positions for the APCs in the hide. But in either case, estimates do not include scout or mortar vehicles.)

TF ELEMENT	HULL POSITION Per	Total	TURRET POSITION Per	Total	TOTAL TIME
Co. A (M1)	.9	12.6	1.5	21.0	33.6
Co. B (M1)	.9	12.6	1.5	21.0	33.6
Co. C (M2)	.8	10.4	1.2	15.6	26.0
Co. D (M2)	.8	10.4	1.2	15.6	26.0
TOTALS		46.0		73.2	119.2

Note: Total time would be greater if the TF had more infantry and Co. E (i.e., more vehicles). Chart assumes emplacement of 12 platoons and availability of two ACEs for 48 hours.

First Lieutenant Kevin Keaveney was commissioned in Armor under the ROTC Early Commissioning Program in 1981. He is a graduate of the University of Arizona and has served as assistant S3, platoon leader, assistant S1, observer-controller at NTC; Armor training officer (range control), Ft. Pickett, VA; and as an assistant S3 at division level. He is a graduate of AOBC and AOAC, Ft. Knox, KY.

Engineer Solution

Step 1: Estimate air content. (Table 3-3, FM 5-742)

a. Aggregate size: 2 inches

b. Air-entrained concrete

c. extreme exposure

Air Content: 5 percent

Step 2: Estimate mixing water content. (Table 3-3, FM 5-742)

a. Slump: 1-2 inches

b. Aggregate size: 2 inches

c. Air-entrained concrete

Mixing Water: 240 pounds per cubic yard (lb/cy)

Step 3: Determine water-to-cement (w/c) ratio. (Check w/c ratios for strength, durability, and watertightness.)

a. Strength (Table 3-2, FM 5-742)

1. Specified compressive strength: 4,000 psi
2. Air-entrained concrete

Water-to-cement ratio: 0.35

b. Durability (Table 3-1, FM 5-742)

1. Frost-resistant concrete
2. All other structures

Water-to-cement ratio: 0.50

c. Watertightness (Table 3-1, FM 5-742)

1. Fresh water exposure

Water-to-cement ratio: 0.50

d. Select lowest water-to-cement ratio from above: **0.35**

Step 4: Calculate cement content (C).

$$C = \frac{\text{Mixing water content lb/cy}}{\text{w/c ratio}} = \frac{240 \text{ lb/cy}}{0.35} = 686 \text{ lb/cy}$$

Step 5: Calculate coarse-aggregate content (CA). (Table 3-6, FM 5-742).

a. CA size: 2 inches

b. Fineness modulus of fine aggregate: 3.0

c. Volume of CA: 19.4 cubic feet per cubic yard (cf/cy)

d. CA weight = volume of CA x dry-rodded weight of CA =

19.4 cf/cy x 110 lb/cf = 2,134 lb/cy

CA content: 2,134 lb/cy

Step 6: Calculate fine-aggregate content by absolute volume method. (A 1-CY mixture).

$$\text{Absolute volume} = \frac{\text{weight of material}}{(\text{specific gravity of material}) \times (62.4 \text{ lb/cf})}$$

Engineer Solution

a. *Absolute volume of cement:*

$$\frac{686 \text{ lb/cy}}{(3.15) \times (62.4 \text{ lb/cf})} = \mathbf{3.49 \text{ cf/cy}}$$

b. *Absolute volume of water:* (See table 3-3, FM 5-742 for wt for water.)

$$\frac{240 \text{ lb/cy}}{(1.00) \times (62.4 \text{ lb/cf})} = \mathbf{3.85 \text{ cf/cy}}$$

c. *Absolute volume of coarse-aggregate:*

$$\frac{2{,}134 \text{ lb/cy}}{(2.7) \times (62.4 \text{ lb/cf})} = \mathbf{12.67 \text{ cf/cy}}$$

d. *Volume of air:*

(% Air x 27 cf/cy) =
0.05 x 27 cf/cy = **1.35 cf/cy**

e. *Summing:*

Cement:	3.49 cf/cy
Water:	3.85 cf/cy
CA:	12.67 cf/cy
Air:	1.35 cf/cy
Partial Volume (PV) =	**21.36 cf/cy**

f. *Absolute volume of fine-aggregate*:

27 cf/cy - (PV) = 27 cf/cy - 21.36 cf/cy = **5.64 cf/cy**

g. *Weight of fine-aggregate:*

lb vol of FA x SGfa x 62.4 lb/cf =
5.64 cf/cy x (2.6) x 62.4 lb/cf = **915 lb/cy**

Step 7: Determine proportions for first trial batch (for 1 cy) by converting absolute volumes to dry volumes.

a. *Cement type 1A:*

$$\frac{686 \text{ lb/cy}}{94 \text{ lb/sack}} = \mathbf{7.3 \text{ sacks}}$$

b. *Water:*

$$\frac{240 \text{ lb/cy}}{8.33 \text{ lb/gal}} = \mathbf{28.8 \text{ gal}}$$

c. *Coarse-aggregate:*

$$\frac{2{,}314 \text{ lb/cy}}{110 \text{ lb/cf}} = \mathbf{19.4 \text{ cf}}$$

d. *Fine-aggregate:*

$$\frac{915 \text{ lb/cy}}{105 \text{ lb/cf}} = \mathbf{8.7 \text{ cf}}$$

e. *Air content:* **5 percent**

This Engineer Problem/Solution was submitted by Captain Michael E. Slavin, who is currently a student at the Combined Arms and Services Staff School. He previously served as executive officer of the 35th Engineer Battalion at Fort Leonard Wood, Missouri. He is a registered professional engineer in Virginia.

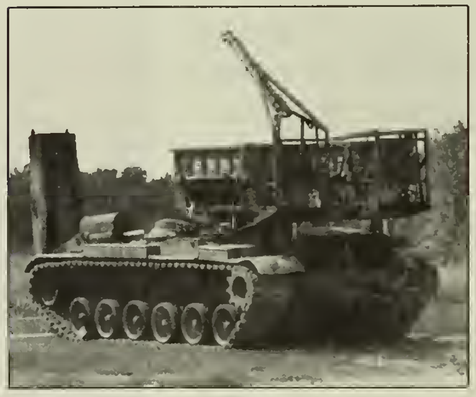
ENGINEER UPDATE

Organizations may find it difficult to contact Engineer School personnel by telephone between October and December 1989. Telephone numbers will change as units move into Hoge Hall, the new schoolhouse, during this period. You may have better luck reaching people by mail. As new telephone numbers are assigned, the Engineer School will try to disperse them through the Reserve Component Training Net (through DA Forum) and DIALCOM computer systems. Please bear with us!

Directorate of Combat Developments (DCD)

Rock Crushing Equipment and Training. Delivery of two new rock crushers is expected in 1990. The first, to be delivered to Fort Leonard Wood in January, will be under the operational control of the 577th Engineer Battalion, 1st Engineer Brigade. The 13th Engineer Company, 19th Engineer Battalion, at Fort Knox, Kentucky, will receive the second in February. The crushers have a minimum capacity of 150 tons per hour and will be equipped with a primary unit (jaw) and a secondary unit (cone). They will be trailer-mounted and diesel and electric motor driven.

Equipment training for the rock crushers will occur in January at Fort Leonard Wood. The 2-week course will include operations and organizations/interim and general support maintenance.


AVLM

Armored Vehicle Launched MICLIC (AVLM) Concept Tested. Tests to evaluate the concept of mounting MICLICs on top of an armored vehicle launch bridge (AVLB) were conducted at Fort Knox, Kentucky, in September. Areas evaluated included driving the AVLM over rough terrain, mounting the MICLICs using organic engineer equipment, and the need for additional training. Initial test results were favorable for the AVLM concept. The Engineer School will receive tentative test results from the Testing Experiment Command's Armor and Engineer Board in October, and final results are scheduled for the first quarter of FY 1990.

Combat Developments Newsgram. The latest actions in combat developments are reported in DCD's monthly "Newsgram." If you wish to be on the distribution list, write to Commandant, U.S. Army Engineer School, ATTN: ATSE-CDP (CPT Ohmann), Fort Leonard Wood, MO 65473-6620.

Department of Topographic Engineering (DTE)

New Terrain Analysis Manual. FM 5-33, *Terrain Analysis*, will supersede the present manual, FM 21-33, when it is published in the spring of 1990. Field comments on the coordinating draft of FM 5-33 are being incorporated into the final text.

Directorate of Military Engineering (DME)

Transition Update. DME welcomed LTC Robert N. Martin as its new director in July. He recently completed the U.S. Army War College and has served in various command and staff assignments.

We are in full swing to make the transition to Fort Leonard Wood a success. Continuity is a concern as instructors and trainers move to the Engineer School. LTC Quesenberry and his staff are conducting the last few EOBC and EOAC courses at Fort Belvoir. The last EOAC class will graduate in December. New instructors, team leaders, branch chiefs, and division chiefs are balancing their time between becoming better acquainted with the EOAC programs of instruction at Fort Belvoir and the challenging task of bringing the courses on line at Fort Leonard Wood.

The first EOAC course at Fort Leonard Wood will begin 5 February 1990. Questions and comments may be addressed to U.S. Army Engineer School, ATTN: ATSE-DME, Fort Leonard Wood, MO 65473-6650.

Directorate of Training and Doctrine (DOTD)

DOTD welcomed COL John W. Pierce, our new director, In August. COL Pierce came to us from the Directorate of Combat Developments.

Tracked Skill Qualification Tests (SQT). With the advent of "Battle Focus," some MOSs that are duty position or equipment specific will have tracked SQTs. The tracked tests will include only the tasks for which the soldiers are responsible. For example, 62B10 will first have tests for tasks that are performed by all heavy equipment operators in that skill level. The remaining tasks will be divided into tracked tests according to the equipment the soldiers operate. The MOSs to be tracked in FY 1990 include 12B, 12C, 12F, 52E, 62B, 62E, and 62J.

Fiscal Year 1990 SQT Notices. All SQT Notices in FY 1990 will include information and instructions to help soldiers prepare for their tests. Every task listed by skill level, track, and task will be tested. The references used to develop the test questions, with publication dates, will be listed at the end of each task list so that soldiers will know which references to use when preparing for the test.

Engineer Officers Advance Course-Reserve Component Records. Academic records for Reserve officers taking EOAC through residence courses, Army Correspondence Course Program (ACCP), inactive duty training (IDT), and active duty training (ADT) are now maintained by the Senior Reserve Component Advisors' Office at the Engineer School. For information, write to U.S. Army Engineer School, ATTN: ATSE-DAC-NG/AR, Fort Leonard Wood, MO 65473-6650.

Computer Mail. Have a question? Like to provide input on current issues at the Engineer Center? Contact the Senior Reserve Component Advisors Office or the Reserve Training Office on either or both of the following networks: DIALCOM or RC Training Net.

U.S. Army Engineer School's Pre-Command Course. Leadership, resourcefulness, and competence are key elements in Fort Leonard Wood's Pre-Command Course. Active duty, Reserve, and National Guard soldiers who attend gain an understanding of current doctrine and refresher training in selected functions and duties related to the Engineer Branch and Total Force concept.

Starting with the first Pre-Command Course in FY 1990, the 2-week engineer phase will precede the Fort Leavenworth phase. This will allow students to become familiar with current engineer doctrine and combat tactics used in the Total Force concept before they go to Fort Leavenworth. Topics include Training in the Army System, Combat Engineering Tactics, Supply Management, Maintenance Management, and Professional Development. For information, write U.S. Army Engineer School, ATTN: ATSE-TDS, Fort Leonard Wood, MO 65473-6650.

First Brigade

M9 ACE

Fort Leonard Wood Holds All the ACEs. Fort Leonard Wood became the first Army post to receive the M9 Armored Combat Earthmover (M9 ACE), when 19 vehicles were delivered on 15 September. Selected combat engineer units Army-wide will receive their M9 ACEs sometime between 1990 and 1993.

The M9 ACE provides combat engineers with a vehicle capable of performing its mission and staying with armored and infantry units. The vehicle is air-transportable, amphibious, fully tracked, and armored. It can prepare fighting positions, river crossings, and obstacles, and it has earth-moving capability. Primary uses include bulldozing, rough grading, excavating, hauling, and scraping.

The 87th Engineer Battalion at Fort Leonard Wood will include M9 ACE training in the Engineer Tracked Vehicle Crewman (12F) and Engineer Construction Equipment Repairer (62B) Advanced Individual Training courses beginning in October 1989. Plans are underway to include hands-on training in the EOBC and EOAC courses that begin in January 1990.

Engineer Personnel Proponent Office (EPPO)

French Army Chief of Staff Awarded Medal. In a history-making ceremony on 15 September, the U.S. Army Engineer Regimental Association presented the regimental de Fleury medal to General d'Armee Gilbert Forray, French Army Chief of Staff. The medal was awarded to commemorate the bicentennial of the French Revolution and to recognize the French Army's contribution to the U.S. Army Corps of Engineers and the American Revolution.

The original medal, awarded by the Continental Congress in 1780, was struck in France. It commemorated the heroic actions of Francois de Fleury, a French engineer and one of the first officers in the U.S. Army Corps of Engineers. His actions in leading the assault on Stony Point, NY, in 1779 exemplify the spirit of the Corps of Engineers and the heritage that the Corps owes to the French Army.

Detachment II, U.S. Army Engineering and Housing Support Center

Prime Power Unit Moves to Fort Leonard Wood. On 1 September, Fort Leonard Wood became the new home of Detachment II, U.S. Army Engineering and Housing Support Center (USAEHSC). The detachment headquarters and one subordinate prime power team relocated to the Engineer Center from Fort Gillem, Georgia.

Detachment II, USAEHSC, is comprised of three prime power teams, which are located at Fort Leonard Wood, Fort Benning, and Fort Sill. The teams are manned by elite, highly specialized noncommissioned officers of MOS 52E. Their mission is to provide utility grade electrical power in support of combat operations during wartime; utility grade electrical power in support of major military exercises and civil initiatives, such as nation building and emergency disaster relief during peacetime; prime power related support to the Directorates of Engineering and Housing in 10 southeastern states.

Detachment II recently completed a 9-month deployment to Honduras in support of Joint Task Force-Bravo. Teams from Fort Leonard Wood and Fort Sill were deployed on 21 September to assist with emergency disaster relief in the wake of Hurricane Hugo.

The role of engineers in 1916

By Dr. Larry Roberts

Throughout 1915 and 1916, an anxious America watched the nations of Europe hurl great armies at each other on the battlefields of France and Belgium. Many Americans wanted to stay out of the "Old World's problems." Some, however, recognized that the U.S. would ultimately become involved in the first great conflict of the 20th century.

A military preparedness movement began in this country, and well known individuals, such as General Leonard Wood, urged their fellow citizens to get ready for war. Major Paul S. Bond, Corps of Engineers, wrote a small book for citizens and soldiers that explained the roles of engineers in modern warfare. Although out of print, the book is now part of the Engineer Archives at Fort Leonard Wood.

Bond described three main functions for field engineers. The first was to "facilitate the rapid movement of combatant forces." He devoted two chapters to discussions of stream crossing operations, equipment, and the construction and improvement of military roads.

The second mission was to "increase the offensive or defensive powers of the combatant forces and to limit or decrease those of the enemy." The chapter on field fortifications and siege operations talked about building trenches and other field fortifications and various obstacles that could limit the enemy's advance. He also described methods of reducing the enemy's defensive works. Part of the engineers' duties in this area included terrain reconnaissance, mapping, and surveying.

(Engineers must) "...facilitate the rapid movement of combatant forces."

Finally, Bond said that the field engineer was responsible for works that maintained the troops' health and promoted their comfort. These works included water supplies, sanitation facilities, hospitals, and buildings for housing troops and headquarters. He concluded the list of functions by adding that "Engineer troops must also be trained to take their place on the firing line in battle, the same as infantry."

In describing the human dimension of engineers, Bond believed that the engineer officer had to be able to withstand the hardships of campaigns and have the professional qualifications of both a soldier and an engineer. The engineer leader had to be resourceful, interested in his work, and a student of human nature. He must know how to handle men under trying circumstances.

Bond cautioned against overspecialization for engineer troops. He believed that the ideal engineer was an "all-around man" who could supervise the operations of specialists, who were part of the national army. For this individual, broad engineering training and high tactical efficiency were essential. Bond pointed out that the field engineer had to practice economy of efforts and resources. His objective was to get the job done sufficiently to support the tactical commander. Too much time spent on making "the best bridge possible" could cause delays and keep commanders from seizing opportunities that arise on the battlefield.

Major Bond's book was a short work (187 pages) that explained to citizens and soldiers what engineers must do in battle. He described operations that characterized both a war of movement and a war of position caused by the trenches in France. There is very little in it that does not parallel the duties and responsibilities of combat engineers today. The equipment has changed, as has some of the techniques, but the basic functions and missions have remained the same.

Bond, P.S, *The Engineer in War: With Special Reference to the Training of the Engineer to Meet the Military Obligations of Citizenship*, McGraw-Hill Book Company, Inc., New York, 1916, 187 p.

Dr. Larry Roberts is historian for the U.S. Army Engineer School and Center, Fort Leonard Wood, Missouri. He previously joined the History Office of the Strategic Command, and later was the School Program Manager for the TRADOC Military History Education Program at the Combat Studies Institute, Fort Leavenworth, Kansas.

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